FLOWERS OF THE LIZARD PENINSULA

The Lizard peninsula is a weird and wonderful place for both the botanist and the casual visitor. The colourful collection of plants and flowers – a striking sight in spring and summer – is of a character unique in the British Isles.

Above: The magenta pink flowers of the Hottentot fig, the white sea campion and the delicate pink thrift combine to make the cliffs of the Lizard peninsula a blaze of colour in the early summer.

The Lizard peninsula in south-west Cornwall, east of Land's End, is the most southerly part of mainland Great Britain. Though its summers are as variable as those of the rest of England, its winters are as mild as such places on the Mediterranean coast of France as Montpelier and Toulon. The rainfall is low for Cornwall, averaging about 102cm (40in) per year.

The peninsula takes the form of a low plateau which, at a few hundred feet above the sea, is only slightly undulating inland. The coastline, however, is bordered by magnificent cliffs or steep rocky slopes, broken at intervals by delightful sandy coves where small streams have cut their way down to the sea. The geology of the Lizard is complex, composed largely of ancient metamorphic rocks. The most remarkable of these is the type known as serpentine. This is rich in magnesium and weathers slowly to form basic, usually well-drained soils. These, however, are toxic to many plants because of the high content of magnesium in them. Nearer the Lizard Point itself, outcrops of different types of rock occur – schists composed of mica, as well as granite-type rocks, which produce drier, more acidic soils.

Floristic features Six flowering plants and one spore-bearing, vascular plant are confined as natives to the Lizard area in the British Isles, and alongside these are found many other rare and beautiful species. The strange flora of this area poses the question of why so many rare plants are concentrated here. Many of them otherwise occur no nearer than the Channel Islands or, in some

cases, even Brittany.

For a long time it was believed that the unique features of the Lizard vegetation were due to the peculiar soils derived from the unusual serpentine rock. Although this may be part of the reason, it cannot be the main cause, because it is now clear that many of the most interesting species do not grow on the serpentine-derived soils at all. Instead, they are found on the schists, or occur on superficial loamy deposits, produced as a result of wind action or carried by glaciers during the Ice Ages.

The explanation of the strange features of the Lizard lies more in its climate and history. Pollen analysis of the heathland peat shows that before the Neolithic period most of the peninsula was forested, either with oakwoods or hazel scrub. The extensive heaths, or downs as they are known locally, are virtually treeless today and are the result of years of clearance, animal grazing or agriculture by early man. The cliffs, however, have probably always been open spaces. Most of the local rarities probably colonized the cliff tops during the fairly rapid warming-up period which followed the last Ice Age, migrating up from south-west Europe while the English Channel was still dry land. This does not appear to have formed a moat to Britain until about 7500 BC, by which time most of our temperate flora was already established.

Cliff-top rarities The most striking feature of the vegetation of the Lizard is the dominance of Cornish heath over several square miles of plateau heathland. This attractive low shrub, with tubular pink, lilac or white flowers and chocolate coloured stamens, is virtually confined to the Lizard in the British Isles. One small colony is found in Northern Ireland, where its native status is still disputed. Common heather or ling is quite scarce on the Lizard, but the heathlands are glorious in August when the Cornish heath flowers.

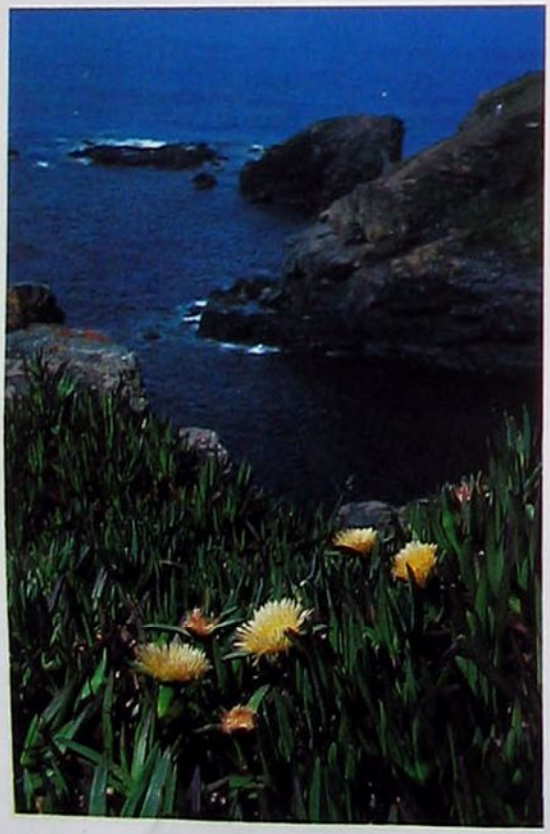
Numerous rare members of the pea family grow on the cliff-top grasslands. Among the short turf of the valleys running inland from certain coves, three particularly rare species of clover are found. Twin-flowered clover and long-headed clover are confined to the Lizard area in the British Isles, but occur southwards from the Channel Islands. The third species, upright clover, is found in only one other place in the British Isles, growing on a rocky hillside in mid-Wales.

These are plants of the schists rather than of the serpentine rock and they form delightful, low-growing communities in short, dry turf in May and early June, along with many other small clovers and other members of the pea family such as hairy bird's-foot trefoil (*Lotus subbiflorus*). This species, although rare, does occur in other dry grassy places along our south coast.

One species which grows on the cliff top

Right: Spring sandwort (*Minuartia verna*), usually found on old lead mine workings in northern England, may occur on the Lizard because of its tolerance of metals such as magnesium, found in the serpentine-based soil.

Below: This member of the pea family, the kidney vetch (*Anthyllis vulneraria*) is usually yellow-flowered. As such, it is common on chalk and limestone grasslands and roadsides throughout much of Britain. Around Kynance Cove, however, it appears from June to September in forms with white, cream, pink, purple or crimson flowers as well as the usual yellow.



Left: On the sea cliffs at the Lizard you can find large patches of the yellow or pink flowered Hottentot fig (*Carpobrotus edulis*). Originally introduced here from South Africa but now fully naturalised, the plant takes its unusual name from the Hottentot tribesmen of Africa, who ate the fleshy fruits produced by the plant. The many-petalled flowers appear from May to August.

in places that are wet only in winter is the sand quillwort (*Isoetes hystrix*). It is also virtually confined to the Lizard, but occurs in the Channel Islands and western France as well. It is almost buried in the soil in which it grows, the quill-like leaves protruding in tufts. This species does not flower, but produces spore capsules embedded in the leaf bases.

Damp ground species Where water trickles down valley paths, or on damp open ground, or muddy areas around pools, two tiny rushes confined to the Lizard are to be found. The pygmy rush resembles a tiny pink toad rush, with pointed leaf sheaths and pointed fruits, while the dwarf rush has single terminal clusters of flowers or fruits with a pair of leaf-like bracts at the base of each. Sedges such as saw sedge (*Cladium mariscus*) and black bog-rush (*Schoenus nigricans*) are also found here, although they are not confined to the area.

Rocky heaths and colourful cliffs In May and June the rocky heathlands on the serpentine around Kynance Cove are a blaze of many colours. This is partly due to the extraordinary range of colour forms of the kidney vetch, and the brilliant flowers of the bloody crane's-bill. More colour is provided by the hairy greenweed (*Genista pilosa*), a prostrate leguminous shrub which produces masses of golden flowers in far greater abundance than in its four or five other British localities. The milky heath violet (*Viola lactea*) forms clumps of creamy, pink-flushed flowers with very narrow leaves, growing along with the starry white flowers of the spring sandwort. Spotted cat's-ear (*Hypochoeris maculata*) resembles a hairy dandelion with lemon-yellow flowers and purple-blotched leaves. The ox-eye daisy also appears here in a tiny form, only 17cm (7in) tall, and may in fact be a distinct species. Indeed, many of the Lizard plants may well be local races of more widespread species that have evolved special forms in order to cope with the unusual habitat.

The cliffs themselves are the home of a rare plant of our western coasts, the purplish-red thyme broomrape (*Orobanche alba*) which is parasitic on wild thyme. The rocky slopes support the prostrate form of wild asparagus (*Asparagus officinalis* ssp. *prostratus*) which is truly wild and found in only a few places.

More common are wild madder (*Rubia peregrina*) a low, trailing shrub with dark green, holly-like leaves arranged in whorls, and western gorse (*Ulex gallii*). This is a rather smaller, late summer flowering version of common gorse.

The vegetation of the Lizard has suffered a great deal from trampling by its many visitors, and the peninsula is now under the care of the National Trust. However, the rare species that flourish on the Lizard must still be protected – taking a photograph is always a much better way to record the existence of a specimen than actually picking it.

Six rare species

Dwarf rush (*Juncus capitatus*). Flowers May-June. Ht to 10cm (4in).

Cornish heath (*Erica vagans*). Flowers August-September. Ht to 80cm (31in).

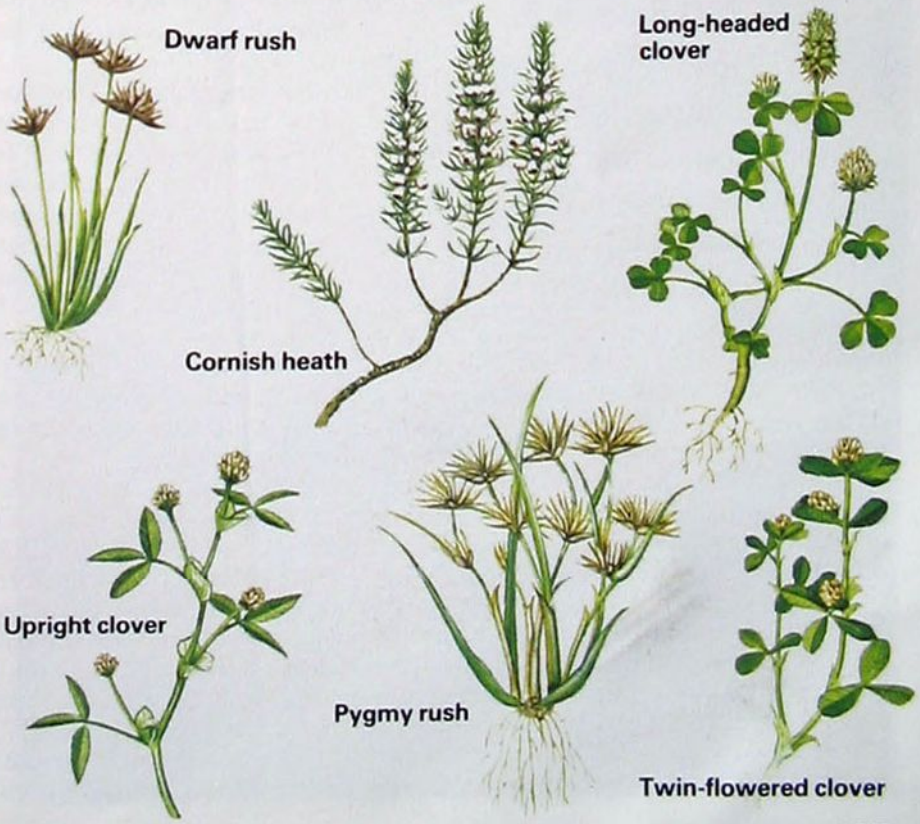
Long-headed clover (*Trifolium incarnatum* ssp. *molinerii*). Flowers June-July. Ht to 20cm (8in).

Upright clover (*Trifolium strictum*). Flowers June. Ht to 15cm (6in).

Pygmy rush (*Juncus mutabilis*). Flowers May-June. Ht to 5cm (2in).

Twin-flowered clover (*Trifolium bocconei*). Flowers July. Ht to 10cm (4in).

Left: The bloody crane's-bill (*Geranium sanguineum*) is rare, but not confined to the Lizard – elsewhere it is found mainly on rocky coasts in northern England. The flowers are large, measuring up to 2.5cm (1in) across, and appear from May to August.



BRITAIN'S LOOK-ALIKE LOACHES

Little is known about Britain's two kinds of loaches for both are secretive fishes and one, the spined loach, is extremely rare.

The only common species of loach in most British rivers is the stone loach, yet even naturalists who spend a lot of time at the water's edge rarely see one. Britain's other loach, the spined loach is, however, virtually never seen. While the stone loach is shy and retiring the spined loach is a total recluse.

Loaches are found in most parts of Europe and Asia, and at the extreme northern tip of North Africa. They are most abundant in south-east Asia, the number of species decreasing the further west you travel. Thus, there are 38 known species of loach in the relatively small country of Thailand; throughout the whole of the Soviet Union there are 31, in Europe six and only two in the British Isles.

Even within the British Isles these two species are unevenly distributed, for the spined loach is found only in the Midlands and East Anglia, the two centres of its distribution being the headwaters of the Trent and the Great Ouse. The stone loach, on the other hand, occurs in a large area of the British Isles.

Burrowing bodies Most loaches have long, slim, cylindrical bodies, well adapted for burrowing in vegetation or for hiding among stones on river beds. Loaches usually have small eyes, relying on barbels fringing their mouths instead of sight to detect their food.

Loaches are closely related to fishes of the carp family. Like them, they have toothless jaws and crush their food with numerous throat teeth lying behind their gill arches. Nearly all, including the two British species, differ from most members of the carp family in being scaleless.

At first sight the stone and the spined loaches seem similar to each other. However, the stone loach has a distinctly cylindrical body, whereas the spined loach is flattened from side to side. The two species also differ in their barbels. Both have six barbels around their mouths, but those on the spined loach are short and scarcely noticeable, whereas the stone loach has long barbels.

The spined loach has one distinct characteristic that sets it apart from the stone loach.

Above: The mouth of a stone loach is surrounded by long barbels with which it searches for insect larvae and nymphs living on the river bed. Being a night feeder, the stone loach's barbels have to be highly sensitive to detect such small prey.

Below: The stone loach is found in most parts of the British Isles, apart from central and northern Scotland, but the spined loach is confined to the Midlands and East Anglia.

Right: **Stone loach** (*Noemacheilus barbatulus*). Distinguished from the spined loach by its cylindrical body and prominent barbels. Length to about 15cm (6in).

Left: **Spined loach** (*Cobitis taenia*). A more flattened body than the stone loach and much shorter barbels. Length to about 13cm (5in).

On the cheek, just beneath the eye, is a strong double-pointed spine hidden in a groove in the skin. Except with a lens, the spine is hard to see, but one sure way of locating it is to run your finger along the cheek of the fish from tail-end to mouth – the spine will almost certainly stick in your finger!

The stone loach This species is by far the more common of the two in Britain. It lives mainly in rivers, although it can also be found in some large lakes with rocky bottoms.

The stone loach is a secretive fish that hides in dense weeds during daylight or, where the bottom is suitable, it may burrow under stones. Occasionally, it may even be found hiding in sunken tin cans or motor car tyres.

At twilight and during the night, however, the stone loach emerges to search for food on the bed of the river or lake. It feeds entirely on bottom-dwelling invertebrates, such as midge larvae, and mayfly and stonefly nymphs.

Spring spawning The stone loach spawns from April to May, its dull white eggs being shed among plants or on gravel.

The eggs hatch in 14-16 days. After a few days the young fry begin feeding on algal detritus. Within five weeks they have grown to 1.5cm ($\frac{5}{8}$in), their barbels are developing and they have begun to feed on small crustaceans. Stone loaches become mature at two years of age and few live longer than seven years.

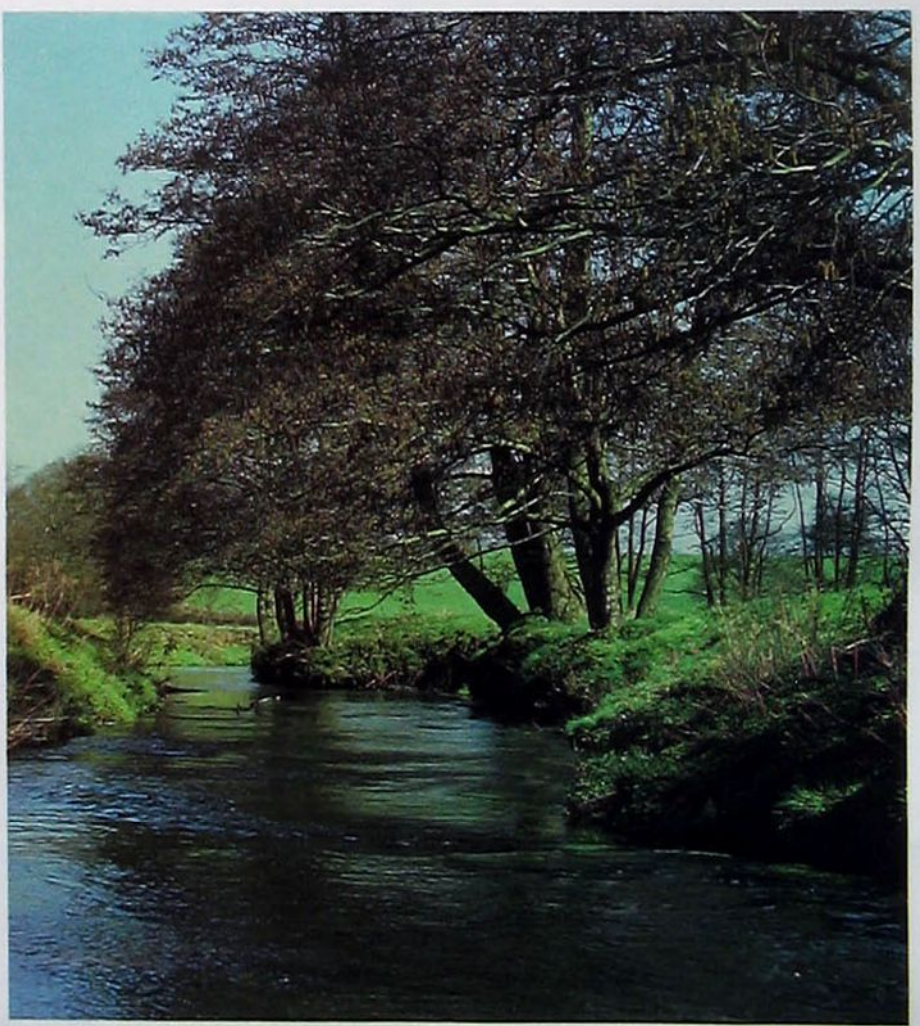
The spined loach The habitat of the spined loach is entirely different from that of the stone loach. It lives in slow-flowing rivers and still waters in river floodplains, where it burrows into the soft muddy bottom in search of food. The spined loach feeds by sucking mud into its mouth. The force of gulping swirls the mud in such a way that the edible organic matter, such as bacteria and nematodes, sticks to mucus in the fish's throat. The sand and other heavy inorganic matter drop to the lower part of the gills and are then pumped out with the water. With such a feeding method, the spined loach obviously has no need of long barbels.

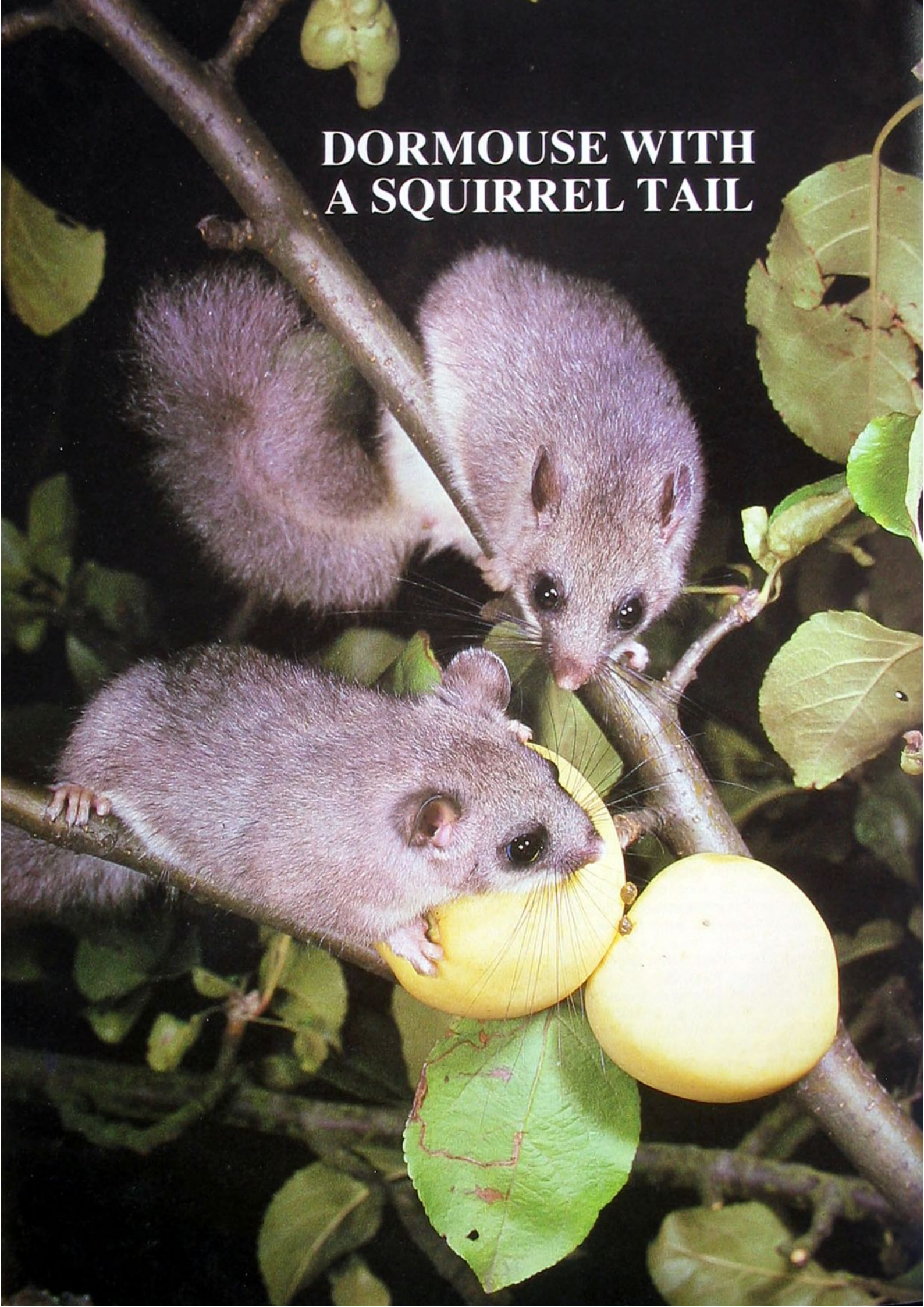
The function of the spines on the cheek is not known, but they may play a part in helping the fish force its way through the bottom mud by providing an anchorage while it curls its body prior to thrusting forwards. The spines do not seem to deter predators.

The spined loach spawns from April to June, laying its eggs on the roots of plants in eddies and backwaters. Spawning seems to take place mostly at night, the fish being more active then than during the day.

In late summer spined loaches can be found in another habitat. At this time of year great masses of green filamentous algae mat the bed of still or slow-flowing rivers; spined loaches burrow into this tangle and are occasionally dragged out accidentally when an angler hooks out a mat of weed.

Below: The stone loach is most commonly found in stony-bottomed rivers, for example the River Wey in Surrey. Muddy rivers, provided they have suitable plant cover, may also hold some stone loach, as do a few large stony-bottomed lakes.
Look for this fish under stones or in weed-beds out of the main current. But remember that you'll have to be fast to catch it as it quickly moves to fresh hiding places.




DORMOUSE WITH
A SQUIRREL TAIL

Once a tasty Roman delicacy, the fat dormouse is a noisy nocturnal animal more often heard than seen in its south-east England habitat.

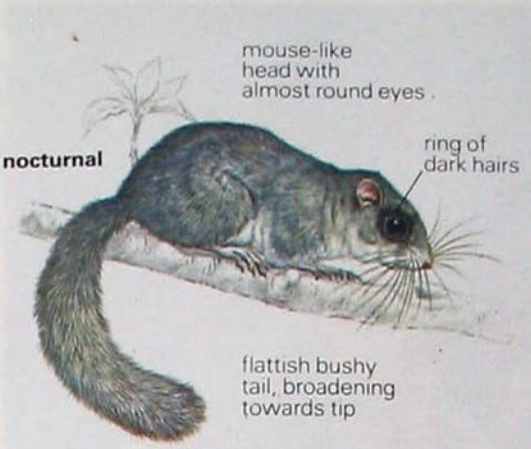
The fat dormouse, also known as the grey, edible or squirrel-tailed dormouse, is one of the two members of the Gliridae family found in the British Isles. The common dormouse is a native, but the fat dormouse, which looks similar to a small grey squirrel, is an alien from Continental Europe and has become naturalised in an area of about 160 square kilometres (100 square miles) in the Chilterns, within a triangle formed by Aylesbury, Beaconsfield and Luton.

Arboreal habitat When the fat dormouse wakes from hibernation in April or May its priority is to regain the weight it has slowly lost in its long sleep, and the first few weeks are spent searching for food. It is mainly a vegetarian, feeding on a diet of nuts, seeds, fruit and tree bark, although insects, birds' eggs and nestlings are sometimes eaten. In Britain it eats a high proportion of stored fruit, especially apples, and causes damage to willow, plum and conifer trees by gnawing the bark.

Fat dormice are the most arboreal of the dormouse family, spending most of their lives in bushes and trees. They are easily mistaken for grey squirrels, and indeed they are squirrel-like in many respects. They are well adapted for life above ground, and are accomplished acrobats. They are able to jump up to 7m (23ft) between branches, and can fall safely from great heights. They are skilled climbers, using their sharp pointed claws to grip the bark, and they can climb even very thin branches, using their long bushy tails as a balance.

Nocturnal habits Fat dormice usually emerge from their nests at dusk to begin the night's activity, although they are occasionally seen by day. They are very vocal, especially during the breeding season, and researchers have noticed two predominant sounds: a series of squeaks two or three seconds long, linked together, which may continue for ten minutes or longer, and a hoarser 'woofle-woofle' or snuffling sound. The series of squeaks is thought to help them locate one another, while the 'woofling' is often heard as they search for food.

As well as having good nocturnal eyesight, the fat dormouse has other senses that help it to explore its surroundings at night. It has very sensitive touch pads on the face, chin and lower arms, and stiff facial hairs (vibrissae) up to 6cm (2.4in) long. These pads and hairs inform the dormouse of its surroundings as it brushes them against twigs, leaves and other obstacles. The ears are broad and prominent, and the dormouse flaps the outer section backwards and forwards twice each second when it is listening.



Adult fat dormouse

During summer the fat dormouse makes a nest of soft vegetation, either in a tree hole or in a fork close to the trunk. The nest is built in deciduous woodland only, never in coniferous forest. In the British Isles fat dormice often make their nests in buildings – barns, stables, and the lofts or wall cavities of houses – using materials such as cloth or paper as bedding.

Single litter The breeding season begins in midsummer. Males court females by following them around in the trees, uttering a soft twittering sound until allowed to mate. Pregnant females isolate themselves and build a breeding nest, either by bringing fresh nesting material into the usual home, or by constructing a new nest in the crown of a tree. The young are born naked and do not open their eyes until 30 days old. They are nursed until their eyes open, the mother straddling them with her legs to form a 'box' in which the young lie on their backs to suckle. This position becomes increasingly uncomfortable

Young grey squirrel

Left: The German name for the fat dormouse is 'der Siebenschläfer', the seven sleeper. It may spend its seven months of hibernation in a burrow, a hollow tree, a woodpecker's hole, a rock or root cavity, the loft of a house, or even a beehive.

FAT DORMOUSE (*Glis glis*), (also known as the grey, edible or squirrel-tailed dormouse).
Size head and body 15-18cm (5.9-7in); tail 13-16cm (5.1-6.3in); weight 150-200g (5.3-7oz).
Colour Silver-grey above, light grey to white below. Ring of black hair around each eye. The silver-grey tail has a parting on the underside which is lighter in colour.
Breeding season June-August. Usually one litter with 5-9 young.
Gestation 30 days.
No of young 5-9.
Food Fruit (mainly stored apples and cherries), nuts, insects, bark of some trees.
Predators Dogs, cats, rats, stoats, weasels, owls. Man – trapping.
Distribution Roughly 100 square miles between Luton, Aylesbury and Beaconsfield.

for the mother as they grow.

Within a few days of birth the mother begins licking the mouths of her offspring, passing on nutrients and bacteria. As they grow they in turn lick their mother, (but never each other). In the nest the young dormice may pick up a parasite, an American squirrel flea *Orchopeas wickhami*, introduced by the grey squirrel.

The young dormice reach adult size in about three months, but do not breed until they are about two years old. They soon become accomplished acrobats, making great leaps between branches, sometimes hanging on by their hind feet. If they lose their footing, they spread their tail and legs to form a 'parachute' and land safely. They may remain with their mother for several months, even through hibernation.

Heavy sleepers In autumn fat dormice prepare for hibernation by steadily increasing their food intake and becoming very fat. If warm material is not already present in the hibernation quarters, the dormice make nests of grass, leaves and moss. Hibernation starts between late September and mid-November, individuals nesting either alone or in communal nests of up to eight animals.

Males hibernate first, followed by females and young animals. During hibernation the dormouse's metabolism is severely reduced and the body shows little sign of life as its stored energy reserves are used. By the end of the seven month hibernation between 35% and 50% of the animal's body weight will have burned up.

Dormice domesticity Under most circumstances fat dormice are not aggressively inclined, and when searching for food several may congregate in a single tree. They may even live in small colonies. Individual home ranges, about 100m (330ft) in diameter, are scent marked with gland secretions.

Fat dormice can live for up to six years in the wild, but the majority fall victim to predation before then, especially during hibernation when they are at their most vulnerable. The most common predators are nocturnal hunters such as owls, stoats, weasels, rats and domestic cats and dogs. They have an escape mechanism that sometimes helps them to give predators the slip: the vertebrae in the tail are very brittle, and if the tail is seized by a predator, the tip breaks off.

Roman delicacy It is probable that during the Roman occupation fat dormice were imported to Britain from Italy. The method of rearing them for the table is well documented. They were fed on acorns, chestnuts and fruit, and for a final fattening they were put into barrel-like earthenware pots (*dolia*) and kept in darkness. They were killed, stuffed with minced pork and dormouse meat, roasted and served with a sweet sauce. Hosts competed to have the fattest dormice, and even today the almond-tasting flesh is regarded as a gourmet's delight in parts of Europe.

The present British population has grown from a group introduced in 1902 by Lord Rothschild. In Europe they can be pests, but in Britain the population is too small and restricted to be a major problem, although they are classed as a pest by the Forestry Commission.

As they are largely nocturnal, they are not easy to observe in the wild, though you may hear them among stored fruit as they roll and bounce apples around. Other signs of their presence are nuts with a large jagged hole in them; nibbled fruit and chewed fruit peel around human habitation; and scuff marks on the ground made by the dragged tail.

Above: Young fat dormice with their mother. It takes them about three months to reach adult size, and they may eventually travel up to 1.2km (¾ mile) to set up a new territory of their own.

Below: To help conserve energy the dormouse sleeps with its tail drawn over its head and abdomen, and with its outer ears folded inwards, considerably reducing the surfaces from which heat might be lost.

KNOBBLY-KNEED SWAMP CYPRESS

One of only two deciduous conifers found growing in this country, the swamp cypress (below) is unique in developing strange knobbly structures called 'knees' around its base – an adaptation that helps the tree to survive in its native Florida swamps.

The swamp cypress comes from the wet swampy woodlands of the south-eastern United States. One of its most famous homes is the Everglades Swamp in Florida, which contains many ancient specimens with their branches wreathed in epiphytes such as Spanish moss, creating an eerie effect. In its native habitat the swamp cypress can reach heights of over 45m (148ft) but, in Britain, it rarely grows to be more than 30m (100ft). The tallest specimen in this country is 35.6m (117ft) and grows at Broadlands in Hampshire.

The first swamp cypress was introduced to Britain in 1640 by John Tradescant, a naturalist who was responsible for many other introductions to this country around that time. It was soon recognised as being a magnificent ornamental tree, growing best in damp ground on rich alluvial soils. In the grounds of stately homes and country houses, lakes, streams and rivers were planted with swamp cypresses, and many have now grown into impressive specimens.

Stringy bark One of the more distinctive features of the swamp cypress is its bark. This is chestnut-brown, furrowed and fibrous, so that pieces of it can be pulled away in strings. The trunk is buttressed at the base and the crown tapers gracefully to form a domed top, rather than the pointed top typical of many conifers.

The most remarkable feature of the swamp cypress is the ring of aerial roots (known as 'knees' or, more properly, pneumatophores) which rise out of the ground around the base of the trunk. These develop only on trees growing in waterlogged soil for they are an adaptation to swampy, oxygen-lacking ground, and allow the tree to breathe. Each knee contains a spongy wood riddled with air spaces through which oxygen from the air can reach the submerged roots. In other words, it acts rather like a snorkel by allowing the roots to breathe while under water.

In older trees, the base of the trunk is often hollow and it has been suggested that this may act as an additional air supply for the roots, though there is no strong evidence to support this.

Above: **Swamp cypress** (*Taxodium distichum*). Deciduous coniferous tree, native to south-eastern USA. The fruits are rounded and about 2.5cm (1in) across. They turn brown when mature.

Deciduous leaves Apart from the larch, the swamp cypress is the only deciduous conifer growing in Britain. Its leaves have the usual conifer shape: linear (needle-like) with pointed tips. However, unlike most conifer leaves, which are hard and waxy, swamp cypress leaves are soft and feathery. When they first emerge in April they are fresh pale green, becoming bright emerald later in the season.

The leaves are borne on two kinds of shoots: long shoots, in which the leaves are arranged spirally, and short shoots, in which the leaves are arranged in opposite pairs. The long shoots remain on the tree for many years but the short ones are shed along with the leaves in the autumn.

Autumn is, perhaps, the time of year when the tree is at its most attractive, for then its leaves turn a superb fiery-red colour before they fall off. In the winter the bare long shoots are marked with rough scars from where the short shoots were attached. Beside these are tiny round scaly buds which are destined to develop into the next year's short shoots.

Catkins and cones The male flowers are borne in catkins in groups near the tips of the long shoots. In March they lengthen to become 8-10cm (3-4in) long. The following month they ripen, turning a dull yellow, and release clouds of pollen which are snatched away by the wind.

The female flowers are set further back on the long shoots. They consist of small globular cones, each constructed from a few thick scales. After being fertilised by the wind-blown pollen, the female cones enlarge, gradually change colour from green to purplish-brown and become woody.

By the autumn the cones have ripened and the scales separate to disperse the seeds, two of which lie beneath each scale. These seeds are woody and triangular with tiny flattened vanes along their edges. In the tree's usual swampy habitat, these vanes are thought to act as water-wings to keep the seed afloat until it is washed up on soft mud.

Durable timber The timber is, not surprisingly, durable when exposed to constant wetting, and for this reason it was extensively used in the United States for making barrels. Being resistant to shrinking, it is ideal for window frames, especially in greenhouses.

In Britain, the swamp cypress has not so far been planted as a timber tree. Yet it is a hardy and vigorous tree over here and will grow quite well on dry soils, so it need not be confined to swampy ground.

Above: Despite its name, the swamp cypress is not a member of the cypress family. Instead it is closely related to the sequoias and giant redwoods. The similarity can be seen clearly in the barks. All three species have a fibrous bark that peels away easily in strips.

Right: In the United States, the swamp cypress is known as the bald cypress after its deciduous habit. Before its leaves fall they turn a dazzling fiery red, making the tree a fine sight in the autumn. Sometimes, the leaves stay on the tree with their autumn colour until well into December.

Knees for breathing

The roots of a tree perform several functions. The most obvious one is to anchor the tree to the ground, but they also extract water and minerals from the soil. To fulfil these functions roots need a continuous supply of oxygen, just as we do. Normally, this is extracted from pockets of air lying in the soil but, in swampy land or near water, the soil is often waterlogged and contains little or no air. To overcome this, a swamp cypress growing in such conditions develops conical growths, called knees, on its roots. These rise out of the water or ground to gain access to the air and, therefore, to a supply of oxygen. These knees (a long row of which can be seen growing here), which can reach a height of 40cm (16in), have domed tops and are clad in a greyer bark than that of the parent tree.

Left: A female of the species *Culiseta annulata*, one of the Culicines, attempting to bite through cloth. These mosquitoes are common around houses and can be recognised by their size (up to 8mm/$\frac{3}{8}$in), black spotted wings and white banded legs. They bite man readily, but do not transmit malaria or ague. The familiar itching lumps that appear on the victim's skin when bitten are due to an allergic reaction to the saliva of the mosquito.

MOSQUITOES – MIGHTY BITERS

More than 30 species of mosquito are found in the British Isles, but although most bite man, few cause more than minor irritation.

There are two different sorts of mosquitoes, Anophelines and Culicines, a distinction which is important medically as Anophelines transmit human malaria while Culicines transmit bird malaria and, in warmer countries, yellow fever, other viruses and parasitic worms.

Although everyone knows more or less what a mosquito looks like, there are many other similar insects that do not bite and which are regularly confused with them.

Mosquito characteristics The average body length of a mosquito is about 6mm ($\frac{1}{4}$in) and with its long legs and two wings it resembles a small crane-fly or a non-biting midge. However, two aids to identification are the long proboscis, which projects out from the head, and the wings which are held in a flat, folded position when the mosquito is at rest.

The larvae and pupae of all mosquitoes are aquatic, so the adults tend to be found in damp places. Only the females suck blood and although some will fly for several miles in search of a blood-meal, 1.5-3km (1-2 miles) is a more usual distance. Male mosquitoes also have a proboscis but they feed only on nectar and fruit juices, which are also taken by the female in addition to blood. A blood-meal seems to be a necessity for the females of most species to ensure the laying of a larger number of eggs.

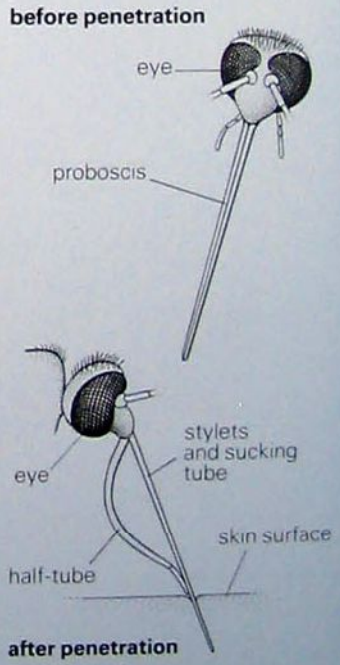
Male mosquitoes have large bushy antennae, making them easily recognisable. They form swarms at dusk over prominent objects, just as midges do, and the females are attracted to these swarms for mating. The males pick up the slightly differing wing-beat frequency of the females with their antennae and coupling takes place in the air, with mating usually completed on the ground.

Life-cycle The life history of a mosquito is well illustrated by that of a common Culicine, *Culex pipiens*, the house mosquito which is abundant everywhere. It breeds in water butts, ditches and other small collections of water, clean, foul or brackish, found around houses or elsewhere. The female feeds on the blood of frogs and birds, including cage birds left uncovered overnight.

How a mosquito bites

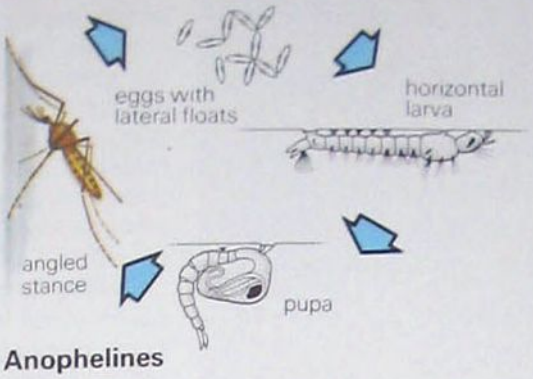
The mosquito's proboscis is not the piercing organ itself, but a hollow half-tube, holding the fine, sharp stylets and sucking tube proper. The sucking tube is the elongated upper lip and floor of the mouth, closely fitted together.

When a mosquito bites, the sharp stylets make the initial puncture, into which the sucking tube is then pushed. The hollow, sheathing half-tube then loops away so that it does not enter, but acts as a support and guide for the stylets. The mosquito uses a muscular pump in its throat to pump up blood, at the same time injecting saliva, which acts as an anti-coagulant and lubricant, into the wound through a duct in the sucking tube.

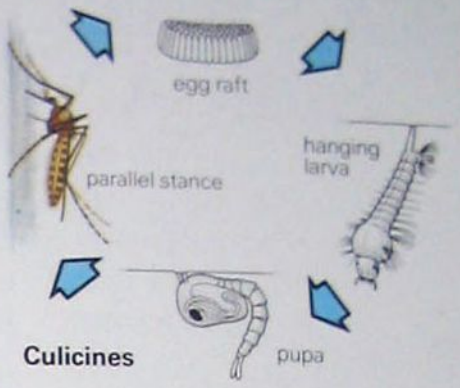


Mosquito life-styles

Anophelines differ from Culicines in several ways. Their eggs have lateral floats and their larvae, lacking breathing siphons, float horizontally below the surface instead of hanging down. The adults also have different stances—Anophelines hold their bodies at an angle to the surface, while Culicines adopt a more parallel position.



Anophelines



Culicines

After mating, the female finds suitable water and stands on the surface, crossing her hind legs to make a V-shaped mould. Into this she lays 150-350 spindle-shaped eggs, which adhere to form a tiny egg-raft, floating on the water. She may lay five or six such rafts in her lifespan of a few weeks in summer.

The eggs hatch after a few days into larvae which have a swollen thorax and a cylindrical abdomen ending in a respiratory tube or siphon. They normally hang by this siphon from the surface water film and feed by sweeping minute organic particles into their mouths with a pair of moustache-like 'brushes'. If disturbed, the larvae swim down with vigorous jerking movements, but soon rise to the surface again. They moult three times before changing to pupae after a week or ten days.

The pupae are normally described as 'comma-shaped', the large head and thorax making the dot of the comma and the flexible abdomen forming its tail. The pupae also hang from the surface film, but the right way up, and not head downwards like the larvae. They breathe through two respiratory trumpets on the top of the thorax. A large air cavity in the centre of the thorax helps to keep the pupae buoyant. The pupal stage lasts only three to five days, then the adult emerges by splitting the dorsal skin and drawing itself out. The newly emerged mosquito rests for a brief period before flying off.

Man-biters There are five species of Anophelines in Britain, all of which bite man and large domestic animals. Two species, *Anopheles messeae* and *Anopheles atroparvus* are important because, although almost identical in appearance, they differ in habits, the latter being the main European malaria carrier. Although they are common where they occur, in practice you are less likely to see an *Anopheles* than a *Culex* or *Aedes* (another common genus).

Anopheles atroparvus lays its eggs on the water's surface, normally in brackish coastal ditches and pools. There are two or three broods a year and the females often used to be found indoors, where they bit man freely. They do not go into complete hibernation, but continue feeding throughout the winter in warm houses and animal sheds, choosing dark, cobwebby corners for resting. *Anopheles messeae*, on the other hand, lays its eggs in fresh water and the females go into complete hibernation in cold buildings. They seem to prefer the blood of domestic animals to that of man.

Disease carriers Malaria or ague used to be common among people living near the fens and marshy coastal areas, particularly in East Anglia and Kent. Malaria is caused by a protozoan which attacks the red blood corpuscles. Mosquitoes pick it up when they bite an infected person. The malaria parasites make large cysts on the mosquito's stomach, before arriving in its saliva, ready to be injected into another person as the mosquito bites. The infected mosquitoes have a reduced egg output.

It has been estimated that as many as 150 million people worldwide may suffer from malaria each year. However, during the last 150 years, the malaria-carrying *Anopheles atroparvus* has virtually disappeared from houses in Britain.

Below: A male *Aedes cantans* exhibiting large, bushy antennae. Our commonest and most troublesome biting species belong to the genus *Aedes*, the largest group of Culicines. The females will fly for more than a mile in search of a blood-meal. They lay their eggs singly in dry hollows that are liable to flooding. The eggs have hard shells and can withstand long periods—even years—of desiccation. They hatch when flooded, usually in autumn or winter, the adults appearing in spring and summer. There may be several generations in wet seasons, the adults breeding in temporary pools in shady places. In or near woods, they are persistent biters of man, but they do not fly far or enter houses.

SEA SWALLOWS: TWO ELEGANT TERNS

The Arctic tern is one of the world's greatest travellers, and the common tern is not far behind it; these two maritime birds, both notable for their graceful flight and endurance, well deserve their popular name of 'sea swallows'.

Below: Common terns calling. Despite their propensity for long-distance travel, common terns can be seen from spring until mid-autumn, feeding close inshore near many coastal resorts.

Terns have aptly been given the popular name 'sea-swallows', for they are perhaps the most graceful and elegant of our seabirds. Silver-grey and white, with darker wing-tips and black cap, and long tail streamers, they are smaller and much slimmer than any of the gulls. All are migrants, travelling to fish in the oceans of the southern hemisphere during our winter, and returning to our coasts to breed in the summer.

The two species most often seen off British coasts during the summer months are the common tern and the Arctic tern. Both fit the general description above, and are so similar in size, shape and plumage that they may often be very difficult to identify with certainty. Because of this, birdwatchers have coined the jargon term 'comic terns' for those whose identity has not positively been confirmed.

Telling them apart If a really close view can be obtained in good light, then you can see some plumage differences which distinguish the two. In a mixed group (and on passage mixtures of the two are often seen) standing on a beach, Arctic terns are noticeably shorter in the leg than common terns: they are so short-legged in fact, as to seem to be sitting rather than standing. Especially during the height of the breeding season. Arctic terns have a totally blood-red beak, while common terns have black tips to their orange-red beaks, often extending to half the beak's length.

Towards the end of the summer, as the adults moult into winter plumage, beak colours become drabber and this feature is less reliable. Both species acquire white foreheads in the autumn. Young birds have blackish beaks and so cannot be separated by this feature. Again, with the birds seen at rest, the tail streamers of the Arctic tern (part of the origin of the term 'sea swallow') extend for a couple of inches or more beyond the folded wing tips, while the common tern's streamers and wings are about the same length.

Perhaps the best separation feature of all is the wing pattern, seen when the birds are in flight. The primaries, or flight feathers, of the Arctic tern appear slightly translucent in the light, giving the impression of an almost luminous white patch in the outer section of the wing. This noticeably bright area has only a very narrow grey-black border along the leading edge of the outermost feather and along the trailing edge of the outer part of the wing. In contrast, the common tern has a pale smoky-grey outer half to its wing, above and below, and its grey-black feather margins are more extensive, especially on the upper wing surface.

Listen to the call There are also slight differences in the calls of the two species, but these require a great deal of experience before they can be successfully used as an identification feature. Both have a long-drawn-out 'keeee-yaaaah' call. In the common tern, the emphasis is strongly placed on the first syllable, which forms the longer part of the call, while in the Arctic tern the two syllables have roughly the same length and emphasis. On migration, the common tern uses a 'kik-kik-kik' call which can sometimes be distinguished from the higher pitched, whistling 'kee, kee' of the Arctic tern.

Terns in spring During the breeding season, terns fish close inshore, 'flickering' along lazily in the air a few feet above the waves before suddenly turning and plunging headlong into the sea. Often these dives result in an audible 'plop' and a considerable splash, but the bird penetrates only a few inches rather than submerges deeply.

Arctic terns are colonial breeders, and the colonies may be thousands strong. They are birds of the Arctic, as their name suggests, nesting on barren beaches and tundra. The nest is a shallow scrape, lined with fragments of shell and sometimes vegetation, and containing one, two or three eggs which are incubated for about a month. The young wander about soon after hatching, and fly four or five weeks later. In Britain and Ireland, not surprisingly, they are birds of remote islands and beaches in the north and west.

Generally, Arctic terns shun areas disturbed by man, but at one of their more southerly breeding colonies, on the Farne Islands, they have become accustomed to the regular but well-managed parties of visitors that are allowed to pay brief visits to their

Above: An Arctic tern brings food to the nest after a fishing flight close inshore. The prey is usually small fish or shrimps, and the fish are caught one at a time, not in a beakful as with puffins. Early in the season the male feeds his mate, an activity known as courtship feeding.

Arctic tern (*Sterna paradisea*); summer visiting seabird, almost entirely coastal. Breeding range more northerly than that of common tern, wintering grounds more southerly. Length 36cm (14in).

Common tern (*Sterna hirundo*); summer visiting seabird, mainly coastal but sometimes nesting inland; length 36cm (14in).

Below: A common tern alights at its simple nest.

Above: Arctic terns breed on islands and beaches in the north and west; common terns breed further south and inland.

Above: A pair of common terns feed their young.

Left: Arctic tern eggs and young alike are perfectly camouflaged: a mixture of greys, fawns, blacks and whites that makes them almost invisible against a background of sand flecked with fragments of seaweed, vegetation and shells. Because of this, it is imperative that a birdwatcher coming across a tern colony should exercise extreme care in moving around: it is far better to sit and watch the goings-on from a distance.

Below: Arctic terns roosting on a reef.

colonies. Indeed, they can be extremely aggressive to intruders, be they predatory birds or mammals such as foxes, weasels or stoats, and will often press home their vociferous dive-bombing attacks to the point of physical contact.

Although many common terns nest in the north of Britain and Ireland, others nest all around our coasts on isolated sandy beaches and shingle peninsulas, or on grassy islands among the mudflats of sheltered estuaries. Additionally, an increasing number are nesting inland, sometimes on natural islands in rivers but, more often, on man-made islands in flooded gravel pits and similar waters. Conservationists now even make large gravel-covered floating rafts, and moor them out in extensive areas of water, finding it relatively easy to tempt a few pairs of common terns to breed on them.

Global travellers Arctic terns probably see more hours of daylight each year than any other bird. Breeding in northern Britain and north into the Arctic Circle, they experience a virtually nightless summer. Having raised their young, they migrate southwards, crossing the equator and passing down the African coast and then on south to spend the winter in the Antarctic Ocean, often as far south as the edge of the ice shelf. Here, of course, it is again summer, and the Arctic terns have the benefit of an immense supply of small fish and plankton. One ringed bird, that lived for 26 years and travelled almost from pole to pole twice a year, must have had an unthinkably high lifetime mileage: certainly several million miles!

Apart from their differences in distribution and nesting habitat, common and Arctic terns are as alike in habits as they are in plumage. As most common terns migrate south to winter off West Africa, it would be easy to suggest that they had a much less extensive range than their Arctic cousins. That is not always true, for ringed common terns have been recovered in Australia, on the opposite side of the world from their British breeding grounds.

SHOP-WINDOWS FOR THE COUNTRYSIDE

Above: Inspecting the cattle lines at an agricultural show. Once shows like this were mobile – moving around and being set up on a new site every year. Now the sheer organisation needed to set up such a show means that the site must be permanent.

Agricultural shows, once no more than small groups of farmers meeting to exchange ideas, now embrace every aspect of country life and are popular everywhere.

There are four different types of agricultural show. These are: the local shows, perhaps held near a market town, and catering for a comparatively small surrounding district; the County shows which, as the name suggests, involve the whole County (and often attract entries from much further afield); the largest shows, such as the Royal Welsh and the Royal Highland, which represent the whole of Wales and the whole of Scotland respectively; and, at the very top, the Royal Show which, although held in England, is generally regarded as 'the shop-window of British agriculture'.

Early history and scope Many of the well-known shows began over a hundred years ago; small groups of local farmers and landowners decided that it would be useful to stage exhibitions of livestock and demonstrations of farming methods to encourage efficiency within their own districts. Before long, the business and commercial interests of local towns and cities connected in any way with the countryside also became involved.

For instance, the Royal Bath and West Show, which has been in continual operation longer than any other in the country, began in 1777. It was the brain-child of a Quaker, Edward Rack, who formed a small society 'for the encouragement of Agriculture, Arts, Manufactures and Commerce within the counties of Somerset, Wiltshire, Gloucester and Dorset and the City and County of Bristol'.

Over the years, shows have increased in number, size, complexity and duration – some now lasting for up to five days. Many have widened their scope to include an enormous range of country activities – from demonstrations of rural crafts such as thatching, to

Below: A champion from the 1980 Norfolk Show. The cattle brought into the show ring are carefully groomed to look their very best before the judges.

exhibitions of local food specialities, local or regional natural history, and competitions such as sheep-shearing.

Originally designed for the exchange of knowledge and views among farmers and growers, modern shows cater for a much wider audience. As finances have become more and more crucial, more emphasis has had, through sheer necessity, to be put on entertainment for the general public. Spectacular displays by the Household Cavalry Mounted Quadrille, the Royal Naval Mast Manning Team, or Police Motorcycle Teams are now important parts of the programme in all major shows.

Show organisation The larger agricultural shows are almost all organised by a committee or council made up of people from various walks of life, both rural and urban, many of them experts in their own particular sphere. Most council members serve on a voluntary basis, but the larger shows are now so sophisticated and embrace so many aspects of country life that they employ a full time executive officer and staff to deal with the office work necessary. As soon as one show is over, work begins on the next – and the most important task facing the staff is to renew the various sponsorship contracts vital to all modern shows.

Above: An old threshing machine on show; these days there is a great deal of interest in restoring and displaying these old-fashioned farming implements.

Right: An eye-catching display of produce set up by the National Union of Farmers.

Below: Taking a fence in style at a local show. Show jumping is always a popular attraction. Although many people come to shows in the first instance to see the well-known personalities of the sport, many stay to look at, and take an interest in, the numerous other displays.

Show sites Up until the last 20 years or so most of the larger agricultural shows were held on a different site each year. However, with costs escalating alarmingly, the movable show became uneconomic, and now a number have their own permanent grounds. A major example of this is the Royal Show, with its 350-acre site at Stoneleigh in Warwickshire, where it has been held since 1963. On this huge site are many permanent features, including exhibition halls, fenced show rings, office blocks, buildings housing the various animal breed society offices, and overnight accommodation for livestock and for the stockmen. The Royal also has permanent livestock units, visited by farmers and breeders from all over the world.

The majority of show grounds are laid out on more or less similar lines. The centrepiece is the main ring, with its permanent or temporary grandstands; adjacent to this ring are one or more smaller rings and, in some instances, special rings for cattle classes near the livestock buildings. From the main ring radiate the tented avenues of trade stands, which sell everything from refreshments to country clothing.

Livestock classes There is a basic pattern for the type of livestock classes held at most shows. Cattle, sheep, pigs, poultry, goats and, of course, horses and ponies – all compete for coveted rosettes and trophies, which are far more prestigious than the comparatively small cash prizes would suggest. These show classes, although perhaps bewildering to the ordinary person who may not always appreciate the finer points of excellence, are nonetheless of great significance to the farming and breeding community. Not only do they set ever higher standards to buyers and other breeders (often from overseas), but they also demonstrate this high standard to world-wide markets.

The horse and pony classes include those for virtually every breed found in the British Isles, including the British mountain and moorland ponies, one of which, the Exmoor, is in danger of extinction. Classes more appreciated by the general public are those for horse and pony driving. These sometimes take the form of a *concours d'elegance* in which the horses and ponies draw gigs, phaetons (light, open, four-wheeled carriages) and traps, some of them up to 100 years old. They are judged on their overall turnout and elegance.

There are interesting regional variations in the livestock classes. For example, at the Great Yorkshire Show, local Rough Fell and Wensleydale sheep can be seen, while in the horse and pony classes the number of Dales ponies are likely to be exceeded only at their own breed show, and there is always a good entry of the handsome Cleveland Bay horses developed in the county. Good classes of Devon cattle are expected at the Devon County Show, while at the Royal Highland the fine classes of Highland and Shetland ponies, the great Clydesdale heavy horses, and the long-coated, big-horned Highland cattle contribute to the typical Scottish atmosphere. The Royal Welsh is known for its Welsh Black cattle and, on judging day, for the Welsh pony breeds and the spectacular classes of Welsh cobs.

Machinery and technology In these days of increasing mechanisation, all the big shows include a section for agricultural machinery, where manufacturers show the latest machines for making farming more efficient. At the Great Yorkshire Show in 1981 a demonstration area was concerned with the methods and equipment for the modern handling, storage and distribution of slurry. Bygone days were not forgotten either, as the Yorkshire Museum of Farming had on display items of historic farm machinery. Old farm machines are, indeed, a feature of many shows.

The very largest shows, such as the Royal and the Royal Highland, are able to stage highly sophisticated displays of farming technology. 'Science into Practice', at the Royal, shows the latest researches of the Agricultural

Scotland Royal Highland, 21-24 June, Ingliston, Edinburgh (1); Peeblesshire, 14 August, Peebles (2).
Wales Denbighshire & Flintshire, 19 August, Rhyl (3); Aberystwyth, 12 June, Aberystwyth (4); Montgomeryshire, 29 May, Welshpool (5); Pembrokeshire County, 17-19 August, Haverfordwest (6); United Counties, 12-13 August, Carmarthen (7).
England Great Northern, 30 August, Preston (8); Great Yorkshire, 13-15 July, Harrogate (9); Lincolnshire, 23-24 June, Lincoln (10); Shropshire & West Midlands, 19-20 May, Shrewsbury (11); Royal, 5-8 July, Stoneleigh, Warks (12); Leicestershire County, 12-13 June, Northampton (13); East of England, 20-22 July, Peterborough (14); Three Counties, 15-17 June, Malvern (15); Bucks County, 2 September, near Aylesbury (16); Royal Bath & West, 2-5 June, Shepton Mallet (17); Surrey County, 31 May, Guildford (18); South of England, 10-12 June, Ardingley (19); Kent County, 15-17 July, Maidstone (20); Royal Cornwall, 10-12 June, Wadebridge (21).

Agricultural shows

Research Councils – 'anything from piglet anaemia to nitrogen use' – while the Royal Highland has a beef evaluation unit on site and a grass and cereal test area nearby.

A livestock feature of interest to British farmers is the small experimental unit at the Royal concerned with the farming of red deer. It has now been in existence for four years and is proving to be financially viable.

Nature, crafts and household Agricultural shows are playing an increasingly important part as shop-windows for the conservation, preservation and appreciation of the countryside in its widest sense. There is hardly a show of any importance in which the local Naturalists' Trust does not have a stand or an exhibition, with an expert to answer questions from the public.

The Forestry Commission is present at the larger shows, particularly those in areas where forestry is of special importance. Their exhibitions range from 'The Living Forest', which is concerned with the wildlife found in forests at various stages in the growth of the plantation, to the more technical subject of 'coppicing', and advice on woodland management. In addition, the National Trust shows films and photographs of properties belonging to the Trust, while the Council for the Preservation of Rural England maintains stands at various English shows.

Right: Among the many displays, competitions and exhibitions, agricultural shows often devote space to demonstrations of rural craftsmen at work. This woodcarver can hold a crowd fascinated for hours just by showing the practical skills of his trade.

Below: A splendid pair of Shire horses in a ploughing match in Somerset – note the horses' brasses and other decorations. Not every show has the room to set up this kind of demonstration – but they are well worth searching for, for the insight they give into farming methods of bygone years.

Rural craft demonstrations are popular items on the programme, and often show a local flavour. At the 1982 Bath and West there was a demonstration of cask-making by the Taunton Cider Company's cooper, which complemented the re-introduction of farmhouse cider-making in the produce classes. Crafts such as dry-stone walling, wheel-wrighting and hurdle and stave-making always attract crowds of interested spectators.

Competitions involving rural skills, such as heavy horse and hunter shoeing, are also popular and, while sheep-shearing competitions are possibly well-known to the show-going public, fleece-wrapping competitions are less so. Other classes based on the practical skills of the countryside include spactacular log-chopping contests, the ever-popular sheep-dog trials and ploughing contests with heavy horses.

Farmhouse products are by no means neglected, with classes for butter, cheese, home-made wine, beer and honey. The larger shows frequently feature a Food Hall which draws together a fascinating display of all kinds of British foods.

On the lighter side, members of the public may be given the opportunity to try their hands at country pursuits – fly-casting, clay pigeon shooting and archery, for instance.

But the sphere of influence of the major agricultural shows does not necessarily end with what can be seen on the show-ground itself. A number hold competitions which take place in farms in the surrounding districts. Competitions for silage making, for farm buildings and works, and for farms judged on visual appearance, general management, livestock, grass and arable crops, fences, hedges, ditches and machinery are held. Some shows also hold competitions for school projects on different aspects of rural life. In all, there's something for everyone.

ELUSIVE HUNTER

Just occasionally, in a few well protected highland areas, the rare and lovely pine marten can be glimpsed among the pine trees, travelling far in search of food.

Generally regarded as the rarest native land mammal in the British Isles, the pine marten, beautiful, lithe, graceful and alert, is about the size of a large domestic cat. Its fur is usually a rich, dark red-brown on the upper parts, but blackish on the limbs and tail. When preserved it often fades to a lighter brown, and this used to cause confusion with the much paler beech marten, so much so that all the older works of natural history state, erroneously, that we have both species in the British Isles.

The pine marten is a typical member of the weasel family (Mustelidae), with a long, narrow body. But it is not so short in the legs, proportionately, as the weasel; and its muzzle is more pointed. Seen in a poor light it is easily confused with the stoat, polecat or mink. The males are noticeably larger than the females.

Habitat Through much of Europe the marten lives in woodland that is a mixture of broad-leaved trees and conifers, and therefore the name 'pine' marten does not at first sight seem very suitable. But it serves to remind us that although the ranges of both martens overlap, the pine marten is primarily a northern species, flourishing in the purely conifer zone of north Europe, whereas its relative, the beech marten (*Martes foina*), belongs only to the south, the zone of beech and other broad-leaved tree species. In the British Isles the pine marten is normally found only in the Scottish Highlands, the Lake District, Snowdonia and the wilder parts of Ireland, especially in the west. Elsewhere it is probably an escape from captivity.

Martens are highly adaptable. In the British Isles, where they have been overpersecuted, they have long survived on treeless moorlands and mountains, among rocks, heather and peat-hags. In winter they have even taken refuge in the hay-barns of hill farms where they have found warmth, shelter and plenty of rats and mice. Probably in the past the pine marten often lived close to farmyards, as the beech marten still does today in Continental Europe.

Shy nocturnal travellers Martens are mainly nocturnal, becoming active at dusk and

The pine marten moves swiftly through remote highland areas of Britain. Its distinguishing marks include prominent rounded ears, a long bushy tail and a throat-patch that is creamy-yellow, or sometimes orange.

Above: Pine marten kittens are born with whitish fur which is gradually replaced by a red-brown pelage. They do not usually emerge from their den until about eight weeks old, although the marten shown here is only six weeks old. Then they are playful, and there is much mock fighting.

PINE MARTEN (*Martes martes*)
Size Head and body 42-51cm (16½-20in); tail 20-24cm (8-9in); weight 1-1.8kg (2¼-4lb). Female about ⅔ size of male.
Colour Dark red-brown on its upper parts, blackish on limbs and tail, throat-patch creamy yellow, sometimes orange.
Breeding Mates July-August, delayed implantation with embryos developing from January, 2-5 young born in March-April, becoming sexually mature at 2-3 years old.
Food Carnivorous: small mammals, birds and their eggs, insects, fish, frogs, lizards, slugs, carrion, sweet fruits, some berries.
Predators Man, occasionally fox, golden eagle.

retiring soon after dawn. They have a reputation for shyness, but it is more likely that they are seldom seen simply because they are so rare. In Scotland they have been persuaded, by regular supplies of food, to make regular nightly visits to gardens and even to come indoors.

Well adapted to an arboreal life by longish legs (good for grasping branches), well developed muscles for leaping from tree to tree, and a splendid tail for balancing, the marten can move through the forest canopy with all the speed and agility of a squirrel. Nevertheless, it hunts mainly on the ground, where it is easily caught in baited traps, especially in winter when it is hungry. It does not hibernate.

Various observers have commented that martens are great travellers, for their tracks have been followed in the snow for many miles over hills and through valleys, often circling back home again. But martens do not necessarily return to the same den each day as badgers so often do; instead they have several dens which they use alternately.

Little is known about the social life of martens. It is usually reckoned that outside the breeding season they live solitary lives, but even so, they doubtless keep a regular eye on each other. Or rather, a regular nose, for both sexes frequently indicate their presence in the same way as badgers, by pressing the scent-glands on their undersides against prominent objects, thus transferring their particular smell to these objects as messages to other passing martens.

This habitat of setting scent is quite distinct from the ability of some animals to emit obnoxious liquids from glands underneath their tails, a habit notorious in American skunks and the British polecat. The polecat was distinguished as the 'foul mart' (or foumart), while the pine marten, which does not produce these stenches, was the 'sweet mart'.

Spring kittens Young martens are produced once a year, the number of kittens seldom exceeding three. Mating takes place in July or August, but because the fertilised egg is not implanted in the wall of the uterus for several months, the embryo does not begin to develop until January, and the young are born in late March or early April.

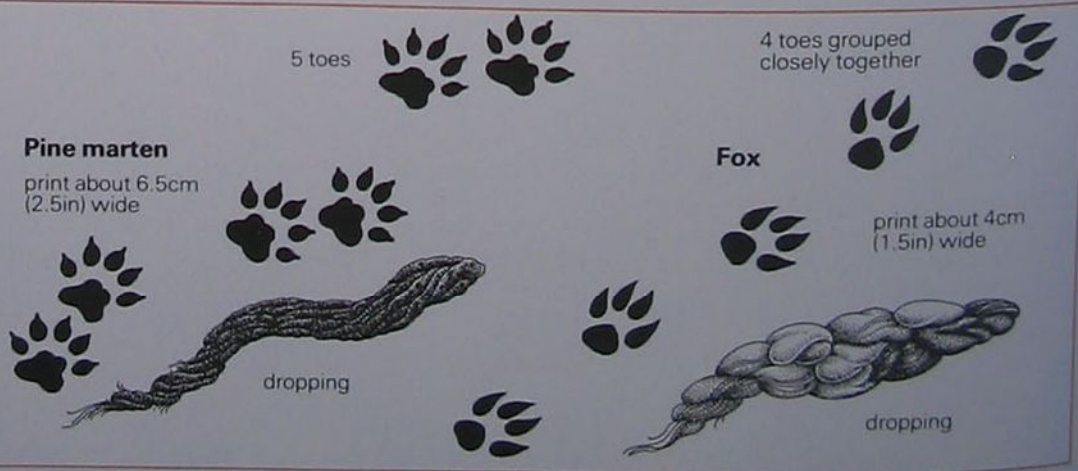
In captivity this delay in implantation can be greatly reduced by artificial lighting, which simulates early spring conditions, causing the martens to give birth in early December. In the wild the young are born in a hole in the ground, under a rock or log, in a hollow tree, a squirrel's drey, or in the nest of a crow, magpie or buzzard.

Because the females do not breed until they are two years old, and after that do not produce young every year, the rate of marten increase is slow. This is evidently why they have not been able to withstand persecution as successfully as more prolific breeders, such as foxes. In captivity martens are reluctant to breed, which largely explains why fur farmers have preferred to breed mink, foxes and chinchillas.

Catholic diet Like that of most of our carnivores, the marten's diet is varied. Besides voles and other small mammals which are probably its staple food in many districts, it also takes rats, rabbits, hares, moles, birds and their eggs, earthworms, woodlice and various insects. Fish, frogs, lizards, slugs and carrion are also on the list, and so are sweet fruits, hazel nuts and ivy berries. Martens have even been reported breaking into bees' nests in hollow trees, and taking the bees as well as the honey. Wasp nests and bumble

Pine marten or fox?

A perfect pine marten's footprint has five toe pads with claws arranged in an arc round a central pad. Quite often the pad is incomplete, showing four toe-pads only, and no clawmarks. Martens follow well-worn paths, marking their territory conspicuously with droppings that often shine with mucus and contain traces of grass, leaves, hairs or feathers.

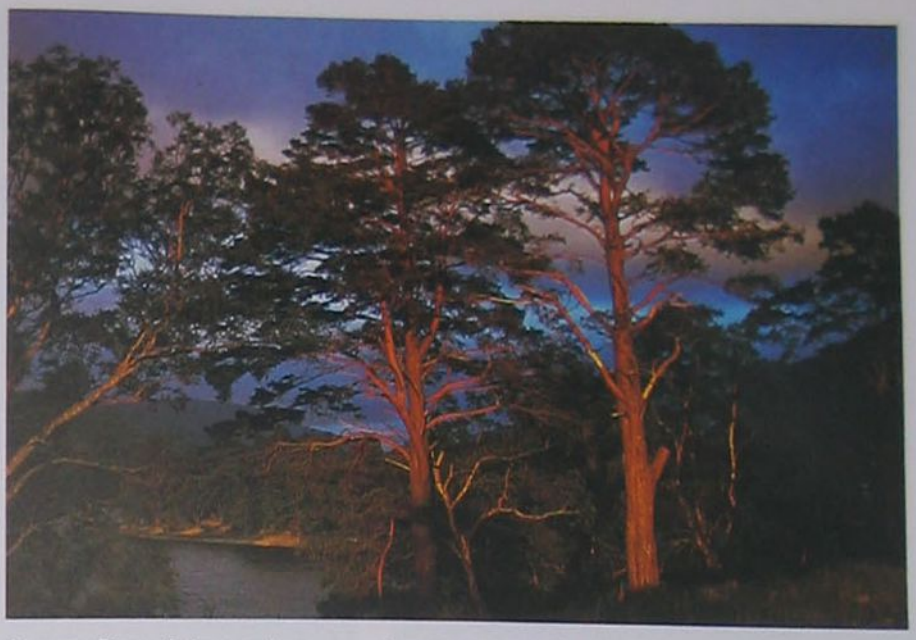


bee nests are likewise attacked.

Changing fortunes Since the bear and the wolf were exterminated long ago, no British wild mammal has suffered more at the hands of man than the marten. It used to be common in most parts of the country, even including some of the off-shore islands like the Isle of Wight and a few of those off Scotland. In some districts it was regularly hunted with hounds, as the fox is today, its fur being easily marketed. It would probably have survived that comparatively low level of persecution. But because it was regarded as a bloodthirsty predator of game-birds, lambs and free-range poultry it was so intensively persecuted by gamekeepers and farmers during the 19th century that it had become almost extinct, even in the wildest places, by the beginning of the 20th century.

Like several other predators, it was saved by the First World War, which diverted gamekeepers to other duties. From the 1920s onwards the marten began to increase, especially in Scotland where it has gradually spread from the extreme north to districts south of the Great Glen. The Forestry Commission's vast moorland plantations also have provided ample cover and food in the form of field voles.

Marten spotting Setting off to seek so rare and elusive an animal calls for the greatest perseverance as well as faith and good luck. It is vital to visit the most likely districts. Even in the Scottish Highlands one's hopes of seeing martens are only slender. There the most frequently recommended locality is the Beinn Eighe National Nature Reserve in Wester Ross where the pine martens truly are the martens of the pines. From the shores of Loch Maree a mountainside nature trail climbs through a surviving fragment of the ancient Caledonian pine forest, and here among trees and rocks the pine marten is occasionally seen at dawn or dusk by those patient enough to wait.



Above: Part of the ancient Caledonian Forest in Scotland on a sunny evening by the River Balharry. Pine martens are very much at home in this type of habitat.

Below: Pine martens eat most species of small mammals, but their varied diet also includes wasps, bees, and even fruit.

Martens may be encountered quite unexpectedly, sometimes even in broad daylight, on open moorlands or on the edges of conifer plantations. Or they may be glimpsed as they hasten across roads at night and are caught in the lights of cars. Any hole suspected of being used by martens should be examined for red-brown hairs, either mixed in with the soil or clinging to the underside of the entrance where the animal has squeezed in. The hole is likely to be much smaller than would admit a fox. It may smell slightly musty, but certainly will not have the strong, distinctive odour of a fox's earth.

Martens are usually silent, but when they are agitated they can give voice to a shrill chattering and screaming that carries far through the stillness of the night. They also grunt and moan, and have a more conversational call note, sounding like a rapid clucking, which seems to be used as a friendly greeting.

Valuable fur There are eight species of marten throughout the world, and their skins are highly prized in the fur trade, particularly that of the Siberian sable (*Martes zibellina*), which grows a specially luxuriant winter coat. Martens have long been trapped for their furs, especially in Russia and Canada, and the Siberian sable has been much reduced in numbers and range. Many furs are now obtained from fur farms so pressures on wild populations are fewer than they were, and the sable particularly is slowly recovering under conservation.

FLOWERS OF SHIFTING SAND

Sand dunes are a unique, but easily damaged, habitat and need the colourful flowers and grasses which grow on them to bind the shifting sand together.

For countless millions of years the relentless pounding of the sea against our shores has been grinding and pulverising rocks into sand. Much of this is carried out to sea and settles on the sea bed, but in many places it is washed up in bays and along low-lying coasts to form sandy beaches.

Above the high-tide mark the sand dries out and is blown landwards by strong on-shore winds, to form loose piles. This shifting sand is colonized by marram grass, which is abundant on the coasts all around the British Isles. It is a remarkable species which is responsible for building sand dunes that can reach a height of 30m (100ft).

Dune ranges formed by the pioneering marram are a particularly unfavourable habitat for plant life. Rainwater drains quickly through the surface, so plants growing there are prone to suffer from severe drought, although marram itself has leaves that roll up tightly in dry weather, reducing the exposed surface and so preventing water loss. Also, pure sand is extremely poor in organic nutrients, which are provided in other soils by the breakdown of dead plant remains. Consequently, it is rather a sterile growing medium. Finally, seedling plants have great difficulty in becoming firmly established in the loose, constantly shifting surface.

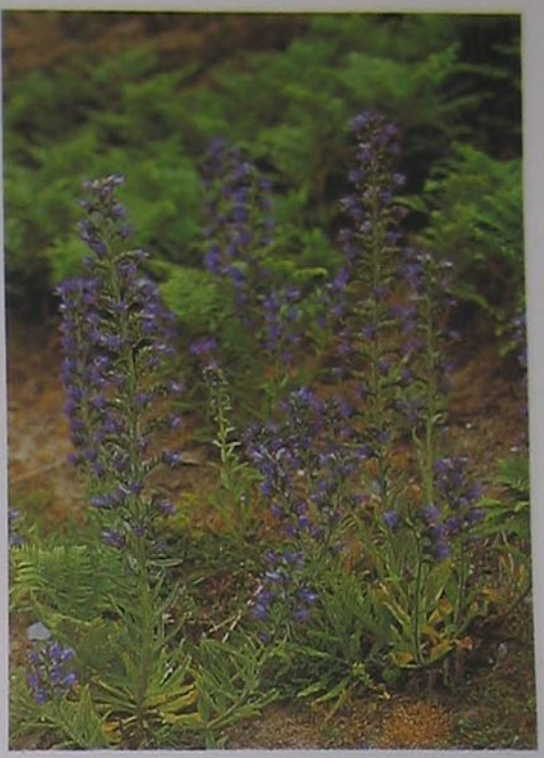
Below: Sea rocket (*Cakile maritima*) has delicate flowers—pale lilac, or sometimes purple or white—which are in flower from June to August along the tidal drift line or at the base of the sand dunes. Like marram grass, sea rocket can tolerate burial in the sand, and sometimes forms tiny dunes of its own.

Hardy sand dweller Sea rocket grows at the foot of sand dunes, close to the high tide mark. It is a rather bushy annual with fleshy leaves and stems which conserve what little fresh water is available in the sand. The delicate, pale lilac flowers are succeeded after fertilisation by short, squat seed pods which are dispersed by the high spring tides. The seeds germinate wherever they are washed up by the sea.

When the sea rocket dies back in late autumn, sand may accumulate, forming mounds around its skeleton. This allows marram grass to take root, and it soon becomes the dominant species, moving landwards into the dunes proper. Unlike the sea rocket, the dune-building marram cannot survive prolonged soaking by sea water, so it grows out of reach of the highest spring tides. Initially it forms widely separated clumps with bare sand in between, but a little way inland it is more prolific and provides a stable environment for other species to take root.

Binding the dunes Sea bindweed is very characteristic of sand dunes which have been stabilised by marram. A creeping plant, it anchors itself to the sand with an extensive underground root system. The long, trailing stems bear fleshy, heart-shaped leaves and conspicuous, trumpet-shaped flowers. These vary in colour from pale pink to mauve and

Left: Marram grass colonizing the dunes in the Scilly Isles. In many sites, marram grass has been planted deliberately, not just to restore the habitat but also because the dune-building powers of marram can be used to create natural sea walls for a fraction of the cost of artificial barriers. The plants can reach a height of 1.2m (47in) and flower from July to August.



Right: The attractive flowers of viper's bugloss, which frequently grows on sand dunes and sandy soils near the sea, appear from June to August.

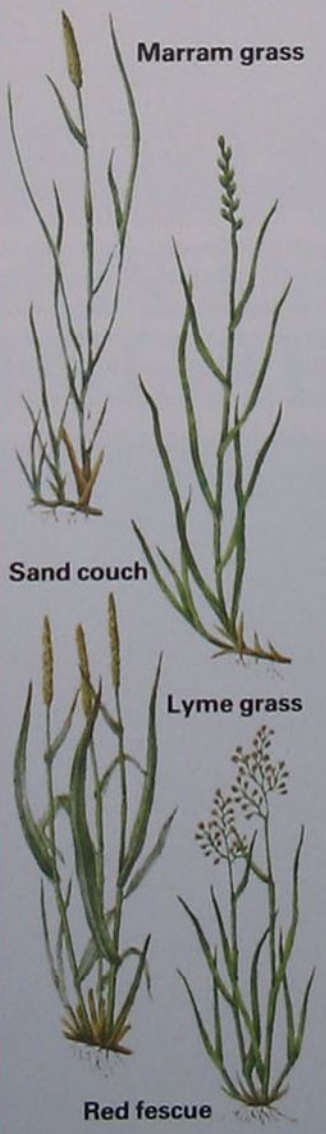
are marked by five pale stripes radiating out from the centre. Pollination is carried out by bees and hoverflies which crawl right into the flower tube in search of nectar.

Sea spurge, another dune-dweller, is an erect perennial with numerous, overlapping greyish-green leaves arranged up the stem. The stem is divided near the top into several short branches which bear clusters of curious flowers. These yellowish-green 'blooms' are characteristic of the spurge family. What appear to be petals are, in fact, small bracts around the male and female parts. The tiny female flower, which has three styles protruding from the ovary, is ringed by several miniature male flowers, each bearing one pollen-producing stamen.

The petal-like bracts form part of a cup surrounding the sexual organs, and the rim of the cup exudes droplets of nectar which attract pollinating insects. The main insect visitors are small flies, but beetles, wasps and bees also make use of the nectar source. Following pollination, the ovary is thrust out of the flower on a rapidly growing stalk, to dangle outside the cup while the seeds ripen inside.

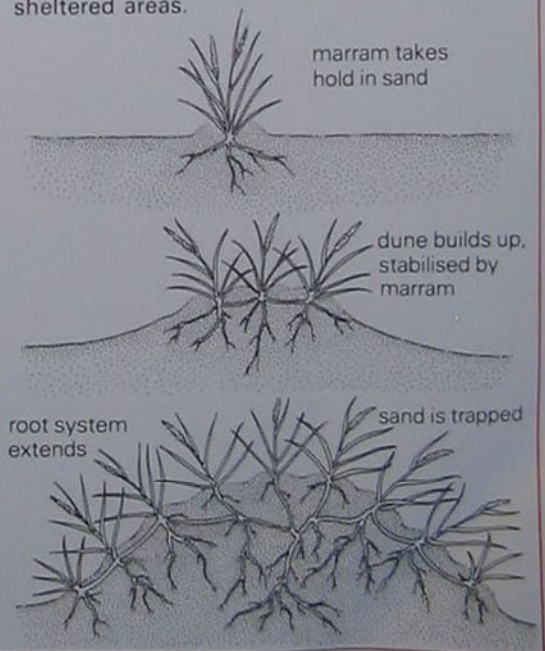
Along with marram grass, these plants help to stabilise the sand with their network of roots. Inland from the shifting, sea-facing dune crests, grasses such as red fescue invade the sheltered hollows and flatter areas. They are protected from the wind by the dune

Building up the dunes



Marram grass has long, narrow leaves that grow in spiky tufts and trap wind-blown sand. The extensive root system spreads rapidly through the loose sand, binding it down. Sand then piles up around the marram plants which grow upwards and outwards as the dune builds up. In fact, marram grass grows best when it is buried repeatedly by sand.

Sand couch and lyme grass are also pioneering species in the dunes. Like marram grass, they both have extensive, spreading rhizomes which help to bind the sand together, although couch grass cannot tolerate frequent burial in the sand. On the fixed dunes further inland, grasses such as red fescue find a home in the more sheltered areas.



Above: The trailing stems of sea bindweed (*Calystegia soldanella*), with their glossy, heart-shaped leaves, may reach 60cm (24in) in length. This species is widespread throughout coastal Britain, apart from Scotland and north-west Ireland. The flowers, which appear from June to August, are wide open by day but close at night.

Below: The distinctive sea spurge (*Euphorbia paralias*) is found on sandy shores and shifting dunes on the coasts of Wales and western England, and all around the Irish coasts. The cupped flowers appear from June to September.

ridges, and the areas of bare sand are clothed with lichens and mosses, stabilising them against the wind.

The dune is now described as fixed. Once it has reached this stage a much wider variety of plants can establish themselves. Marram grass may still be present in the fixed dunes, but it is sparsely scattered. It normally grows in pure loose sand and cannot compete with the other species which now move in to colonize the fixed dunes.

Dune rose The burnet rose is one such colonizer. It spreads by means of underground stems called suckers to form low, creeping thickets. The arching stems are densely clothed with bristles and short spines, and the leaves consist of seven to nine oval leaflets. These have saw-toothed edges and may be faintly hairy on their undersurface.

The flowers first appear in May; five creamy-white petals frame a collar of many bright yellow stamens surrounding the centrally located female styles. The bloom does not produce nectar, but has a delicate fragrance. This attracts insects, which feed on the copious amounts of protein-rich pollen contained in the flowers. As the insects climb over the clusters of stamens, they unwittingly pick up pollen which is transferred to the next flowers to be visited, so effecting cross-pollination.

In the autumn, the flowers are succeeded by dark crimson-coloured hips. These are the fruits, containing several seeds embedded in a fleshy pulp.

Fixed dune flowers Common centaury is another species with a distinct preference for sandy ground. It is a small plant, with a basal rosette of oval leaves and additional widely spaced pairs of leaves clasping the stem. The small rose-pink flowers, measuring 10-15mm ($\frac{2}{5}$-$\frac{1}{2}$in) across, are composed of five petals fused into a flower tube.

Viper's bugloss is a much larger plant, its robust stems densely covered with stiff hairs. A biennial, it passes the first winter as a rosette of bristly, narrow leaves and does not flower until its second year. The flowers unfold from pink buds in June, turning a beautiful bright blue.

This species can be a persistent weed on farmland because of its long, thick tap root which contains ample reserves of food to fuel the regeneration of the leaves if the rosette is cut off. This also helps it to survive in the rather arid environment of the dunes.

From ancient times, viper's bugloss has been associated with snakes, as its name suggests. The fruit is composed of four triangular-shaped nutlets which are said to resemble a snake's head. They were consequently used to treat snake bites, though probably with a limited degree of success.

Above: Redstarts are forever active birds, restlessly flitting about among the twigs or down on to the ground to seize some insect or caterpillar. In autumn they augment their diet with ripening berries.

THE COMMON AND BLACK REDSTARTS

The redstart is an elegant summer visitor that breeds in mature, open woodland over much of England, Wales and Scotland. It has a town-dwelling cousin, the black redstart, which can sometimes be seen in industrial or derelict sites – places that are not often visited by birdwatchers.

Below: Redstarts are more common in the north and west, but almost absent from Ireland. Black redstarts, on the other hand, favour the south and east.

The distinctive feature of redstarts of either sex and any age is the orange-chestnut tail, with its slightly darker and browner central stripe. Redstarts' tails are constantly on the move, with a perpetual up-and-down quivering, unlike the tails of robins or stonechats which have a precise, flicking motion. Their very name is derived from this distinctive tail: the 'red' is obvious, but the 'start' is derived from the Anglo-Saxon word *staert* which means a tail.

In the male, this conspicuous tail is enhanced by a chestnut belly (fading to buff around the vent), a chestnut rump, and by a back, mantle (the back of the neck) and crown of an elegant dove grey. His forehead is white, his face and throat jet black. Altogether, this must be one of the most beautiful of British birds, strikingly so during his display flights, when he flits rapidly between the trees. The females and young birds are altogether drabber, having grey-brown and orange-buff plumage.

Life in the woods Although its original habitat in Britain may well have been sandy heathland with large pine trees (now found only in the south), the redstart is today more typical of northern and western Britain, and, rather strangely, it is almost absent from Ireland. It seems to have adapted well to the loss of much of its ancestral habitat, and has become a bird of old deciduous woodland

(particularly sessile oak); parkland with well spaced, stately but ageing trees; and meadows with pollarded willows along their margins. In northern Scotland, open pinewoods and large birches remain its favoured habitat.

Nests in southern England are usually in holes in branches or tree stumps, but in dry areas they may occasionally be at the end of short burrows. In the north, nests in crevices in rock faces and stone walls are more common. Redstarts readily take advantage of nest boxes, provided the entrance hole is large enough – larger than that needed by tits at 3.6-4.8cm (1½-2in) in diameter.

During nesting or afterwards, as they move about in the bushes and trees, redstarts very much resemble slim robins in carriage and behaviour. They have a plaintive 'whoo-eet' call, easily mistaken for that of the willow warblers that are usually plentiful nearby. They also have a soft 'twick' of alarm, and a brief but nonetheless melodious little jingle of a song, again with much of the quality of the robin about it.

African migrants Ringing recoveries indicate that our redstarts winter in West Africa, and a series of declines in the British redstart population has been linked to periods of drought in their winter quarters, in much the same way as the drought in the Sahel region adversely affected the whitethroat.

An unusual relative Although at first sight it may seem far drabber than its woodland cousin, the male black redstart – especially when fully mature at three or four years old – has, on close inspection, particularly fine plumage. The tail is typical of the redstarts, being a rich chestnut-red, but there is no trace of orange or buff on the underparts. The head, mantle and back and the throat, breast and belly are all dark grey, becoming black with successive moults as the bird gets

Above: A female black redstart with her nest in a deserted shed. The clutch usually contains four to six shining white eggs, occasionally with a faint peppering of fine brown spots. They are incubated by the female for just under a fortnight, and fledge about 16 days after hatching.

Right: Common redstarts make a neater nest, in which they usually lay five or six eggs; these are usually blue, occasionally with a greenish tinge or freckled with brown. Incubation again is just under a fortnight, and the young fledge after about 14 days. Both species usually have two broods each summer.

Below: A male redstart stands guard over the brood.

older. The wings, too, are black, with a striking white patch in mature birds. Females and young birds are far more difficult to tell from redstarts unless a good view is obtained, but black redstart underparts are always grey, and never buff or orange as in the common redstart.

Across much of Europe and Asia, the natural habitat of black redstarts is rocky mountainsides, where they feed on a wide variety of insects caught on the ground or on the wing, and nest in crevices between boulders. Black redstarts also form an attractive component of the bird life of many European towns and cities, usually associated with large old buildings where crumbling masonry has provided suitable nest-sites. In their association with man they are probably most typical of the whitewashed walls, geraniums in hanging baskets and colourful tiled roofs of Mediterranean cities, towns and villages. Particularly numerous in southern France and Germany, they range as far north as Denmark and Latvia to breed. They are short-haul migrants; the more northerly birds winter in the Mediterranean basin, while some populations rarely migrate at all.

In consequence, it comes as something of a surprise to find that a bird so numerous, homely and widespread on the Continent should be so scarce in Britain. Perhaps one hundred pairs breed in England in an average year, mostly in the south and east. It is also surprising to discover that only in the middle years of the present century did they become firmly established here as breeding birds.

Above: Redstarts are hole-nesters, and it is often argued that keen competition for the nest holes (from tits, pied flycatchers, nuthatches and others) is the only restriction on the growth of the redstart population.

Above: A young black redstart perches on scrap metal. Besides derelict factories and yards, the birds also favour some active sites—docks, warehouses, gasworks and power stations.

Redstart (*Phoenicurus phoenicurus*); summer visitor to mature, open woodland; 14cm (5½in).

Black redstart (*Phoenicurus ochruros*); small breeding population in towns; 14cm (5½in).

Wartime arrival The story of their colonization is an intriguing one. Apart from a few isolated records, the first substantial breeding reports were published in the earliest days of World War II. In May 1939 a male was found singing in Bloomsbury—in most illustrious circumstances—from the towers of the University of London and the nearby British Museum. Bombing had begun in real earnest when breeding was proved in the summer of 1940, in Inner London and again illustriously, this time in the shadow of Westminster Abbey. Although breeding was reported in other southern counties, London remained the stronghold of the British breeding population as it increased over the wartime years. Many of the breeding pairs were in the City of London, and took advantage of the devastated buildings and piles of rubble (doubtless reminiscent of mountain screes) in the blitzed areas to feed and to conceal their nests.

The many reports and articles on black redstarts that were published during the war rarely gave any detail of the habitat, probably for reasons of security so that the enemy did not gain too clear a picture of the extent of the damage. By the end of the war, the black redstart population, though still with its stronghold in London, was spread over at least 11 counties and had reached about 50 pairs.

At that stage, startling fresh information was released. In 1944, the journal *British Birds* published retrospective information on breeding, described as 'one of the most remarkable discoveries of recent years in British ornithology'. A caretaker at the Wembley Palace of Engineering (which housed the great Empire Exhibition of 1925) told the authors of the article that during the years 1926-41—since the closing of the exhibition—three pairs of black redstarts (and once four) had nested there every year.

After the war, the breeding black redstart population fluctuated, sometimes reaching 60 recorded pairs, sometimes falling as low as 20. In the early 1970s there was a continuing rise in the number of nests reported, and the present-day level of around 100 pairs was established. About one third of the breeding population is in the London area, the remainder largely in the south-east and East Anglia, with a scattering of records in the Midlands and the most northerly in Yorkshire and Cheshire. In a 1977 survey, 98% of sites described were man-made.

SPIDERY HARVESTMEN

Harvestmen are long-legged, spider-like creatures found bobbing about among low vegetation, spread-eagled on the shady side of tree trunks and under window sills.

Above: A male specimen of *Phalangium opilio*, showing the horned chelicerae and the drawn-up, leg-like pedipalps or sensory limbs. Both *Phalangium opilio* and the leiobunid species (below) have very long second legs which are used to monitor their surroundings. Harvestmen sometimes sit in groups with their second pair of legs in contact. If one of them detects a disturbance, this is transmitted through these legs to the others, and they all move off to safety.

Harvestmen are now a dwindling group worldwide. There are only 23 British species, all of which belong to one of the three sub-orders of the Opiliones: the Palpatores, a name derived from their use of palps to sense food. Harvestmen are also known as harvest-spiders and harvesters, and are sometimes incorrectly called daddy-long-legs, a name better applied to craneflies.

Spotting the difference Despite their name and appearance, harvestmen are not very closely related to true spiders. The body of a harvestman appears to be undivided whereas that of a spider is clearly in two sections joined by a very narrow waist. The second legs of the harvestman are obviously the longest – in most species markedly so – but there are few British spiders with second legs longer than the other pairs. One confusing characteristic is that harvestmen have a pair of sensory limbs, known as pedipalps or palps, which look like an extra pair of legs and appear in front of the first pair of true legs. (Spiders also have pedipalps, but they are not so pronounced.)

The number of eyes is also an identifying factor. Harvestmen have only two, set on a little bump (the ocularium) towards the front edge of the upper side of the body. Most spiders have four, six or eight eyes set round the front edge of the cephalothorax. In both groups, the eye is a single lens, but in harvestmen it probably does little more than distinguish light from dark and detect movement. However, on each side of the front edge of a harvestman's body is an eye-like organ, which is in fact an odoriferous gland – one of the few methods of defence which a harvestman possesses. It emits a strong-smelling substance which has a deterrent effect on would-be predators such as ground-beetles, ants and lizards.

A final major difference between harvestmen and spiders is that spiders produce silk, although not all species spin webs, while harvestmen have no silk glands and cannot spin.

Sensory equipment Harvestmen use their leg-like palps to sense food. The palps react to chemical stimuli such as the smell of the bodies of small insects and other invertebrates, as well as dead animal flesh, bird droppings and water, all of which feature on the varied but essentially carnivorous menu of the harvestman.

The long second pair of legs are important in giving the harvestman information about the world around it. As a harvestman moves slowly along in rank vegetation, these legs are in constant motion, tapping the surface here and there like a blind person using a walking stick. If something comes within the harvestman's sphere of detection, disturbing the vegetation or the air, the legs are suddenly raised to detect the direction and intensity of the disturbance.

The loss of one of this second pair of legs seems to make little difference to a harvestman, but if both are lost, the individual rarely survives for long.

Reproduction and development In most British species, maturity is reached in July and mating takes place from then onwards. The female has a long, flexible ovipositor which she uses to tuck away her white, oval eggs in cracks in the soil or in moist, rotting wood, or anywhere else where they will not dry up. The eggs are usually laid in batches of about a dozen, and most species overwinter in this stage, the adults having died with the approach of winter.

When the temperature reaches the necessary level the following spring, the young harvestman develops rapidly within the egg. Newly hatched harvestmen are delicate, white, long-legged creatures. At this stage many fall prey to ground-beetles, centipedes and other predators. Others may perish if stranded in a dry atmosphere. Those that survive quickly grow bigger and moult eight times before they are mature, although at all stages the harvestman resembles a small adult.

Ground-dwellers All harvestmen live among damp moss, low vegetation or in shady places, becoming active at night when the atmosphere is moist. Five British species spend their entire lives on the ground.

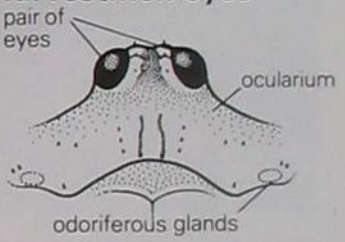
The two members of the family Trogulidae are unusual in appearance, with short legs and a remarkably flattened body with a forward-projecting 'hood'. As adults, they produce a sticky secretion on the skin to which earth particles adhere, making them resemble lumps of soil. Both species are uncommon, appearing mostly on calcareous soil in the south, perhaps because this soil supports large populations of the snails they feed on.

Homalenotus quadridentatus, easily recognised by the four 'teeth' at the end of its body, is also found on calcareous soils, while the other ground dwellers, two members of the Nemastomatidae family, prefer moss and leaf litter. They are also found under flower pots and seed boxes in the garden where *Nemastoma bimaculatum*, with a black body marked with two clear white spots, is unmistakable.

Bush and tree dwellers Our other species of harvestmen generally have longer legs and inhabit low vegetation, bushes and trees. Most species tend to favour the southern half of Britain, although some species are common and widely distributed. *Phalangium opilio* is one of the most common and distinctive. The mature male has large, upward-projecting horns on the knee-joints of its chelicerae–small limbs with grasping claws, situated between the palps. It also shares the record for the length of the second leg–which may exceed 5cm (2in) in large individuals–with the two species of the genus *Leiobunum* and the species *Dicranopalpus ramosus*.

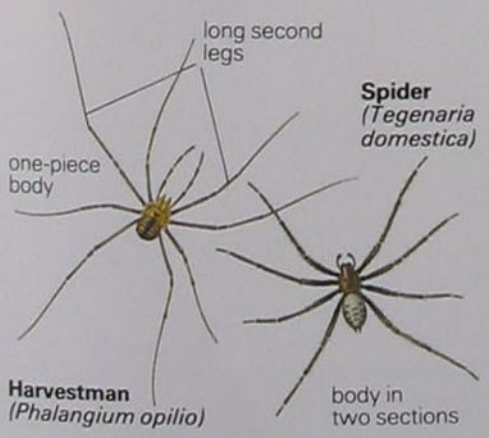
Above: *Homalenotus quadridentatus* is a southern species of harvestman. It is easily identified by the four 'teeth' which appear on the apparent end of its body–they are in fact on the fifth segment, out of a total of ten segments.

Harvestmen eyes

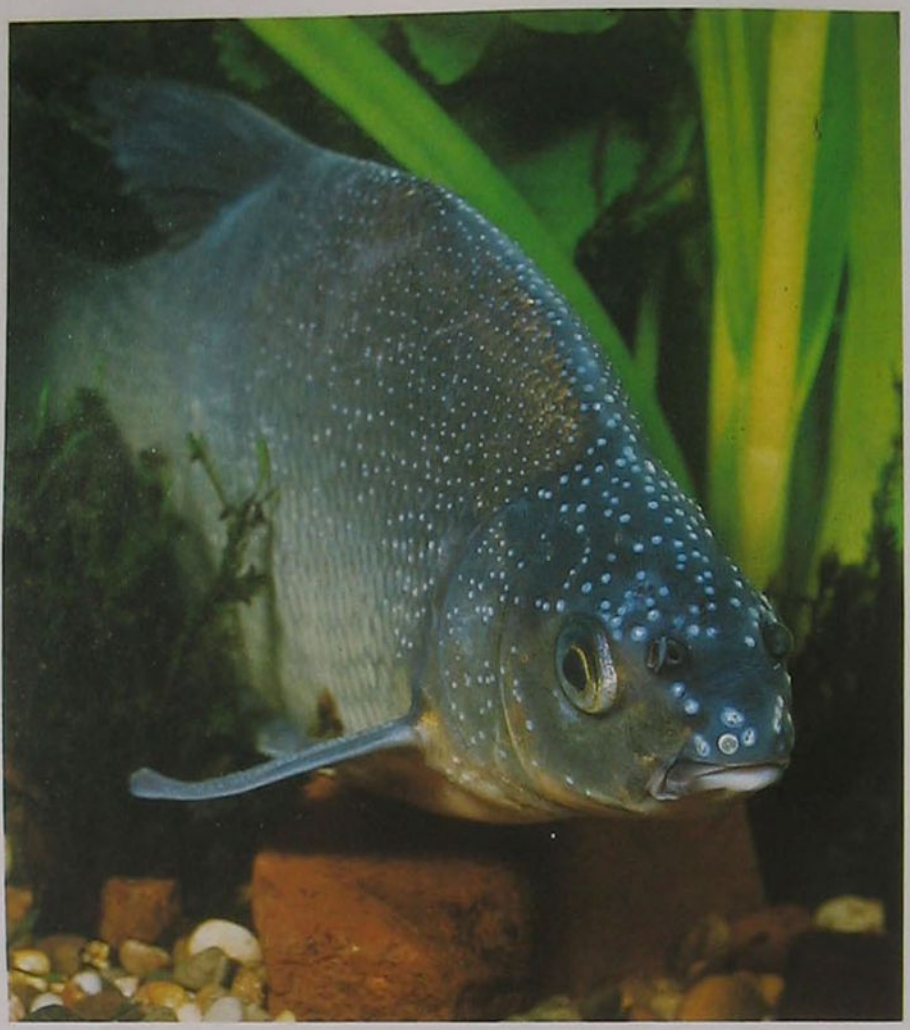


Below: A common species, *Mitopus morio*, carrying bright red parasitic larval mites which occasionally attach themselves to harvestmen and feed on their blood, as well as taking advantage of a free ride.

Spider or harvestman?



Harvestmen can be distinguished from spiders by their body shape, which appears undivided rather than in two sections; their very long second legs; and their eyes–two in the harvestmen, four to eight in most spiders.



SHOALS OF BRONZE AND SILVER

No other British fish forms such huge shoals as our two bream – the common or bronze bream and the rarer silver bream. Thousands of fishes can be found together, all churning up mud as they scour the river-bed for small bottom-dwelling creatures.

Above: At spawning time in spring the males of both the common and the silver bream develop white growths, called tubercles, on their bodies. These occur mainly on their heads but they often spread to the rest of their bodies. The tubercles are rough to the touch and their presence may be connected with the males' practice of bumping and nudging the females prior to spawning.
The tubercles on this male common bream can be seen clearly.

As its name implies, the common bream occurs much more frequently in Britain than the silver bream. It is also known as the bronze bream, yet its body colour is really a dark olive, though there are variations. Younger common bream are often a pale silvery colour, whereas old specimens sometimes become a true metallic bronze; this colour may also vary with the environment.

Britain's other species of bream, the silver bream (also known as the white bream), is a smaller fish than the bronze bream. It rarely grows longer than 36cm (14in), compared with an average length for the common bream of 40-50cm (16-20in). Unlike the common bream, the silver bream does not have any colour variations, always being silvery with pinkish pectoral and pelvic fins.

The best way to tell the two species apart is by counting the number of scales on the lateral line and the number of rays in the anal fin: in the bronze bream there are 25-30 rays and 51-60 scales, and in the silver bream these figures are 21-23 and 44-48, respectively.

The fishes hybridise freely when both inhabit the same water, the hybrids being intermediate in colour, scale pattern, number of rays in the fins and so on. Similarly, hybrids occur between both bream species and rudd and roach. In all cases the numbers of fin rays and scales on the hybrids are intermediate between those of the parents.

Ancient arrivals The common and the silver bream are native to the streams of south-east England, from the Thames north to the Trent. They arrived in Britain just after the last Ice Age. At that time, England was joined to the Continent and rivers such as the Thames and the Trent were tributaries of the Rhine. Bream (and many other species) spread down the Rhine and into these English rivers. When England was separated from the Continent with the formation of the English Channel, the bream here were isolated.

From a focus in south-eastern England, the common bream has spread to many other parts of England, and has been successfully introduced to Wales, Scotland and Ireland. The silver bream however, is confined mostly to East Anglia.

The typical habitat for both species is a weedy slow-moving lowland river such as the Nene, the Welland, the East Anglian rivers and the Somerset drains. There are big populations of bream in man-made lakes and reservoirs, old water-supply lakes at the head of canal systems and the Norfolk Broads.

Shoals of thousands No other British freshwater fish forms shoals as readily as the bream. It lives all its life in shoals, some of which can number thousands of individuals. As the members of a shoal get bigger, so their numbers decrease, and bream over 5kg (10lb) in weight may move around in groups of as few as ten.

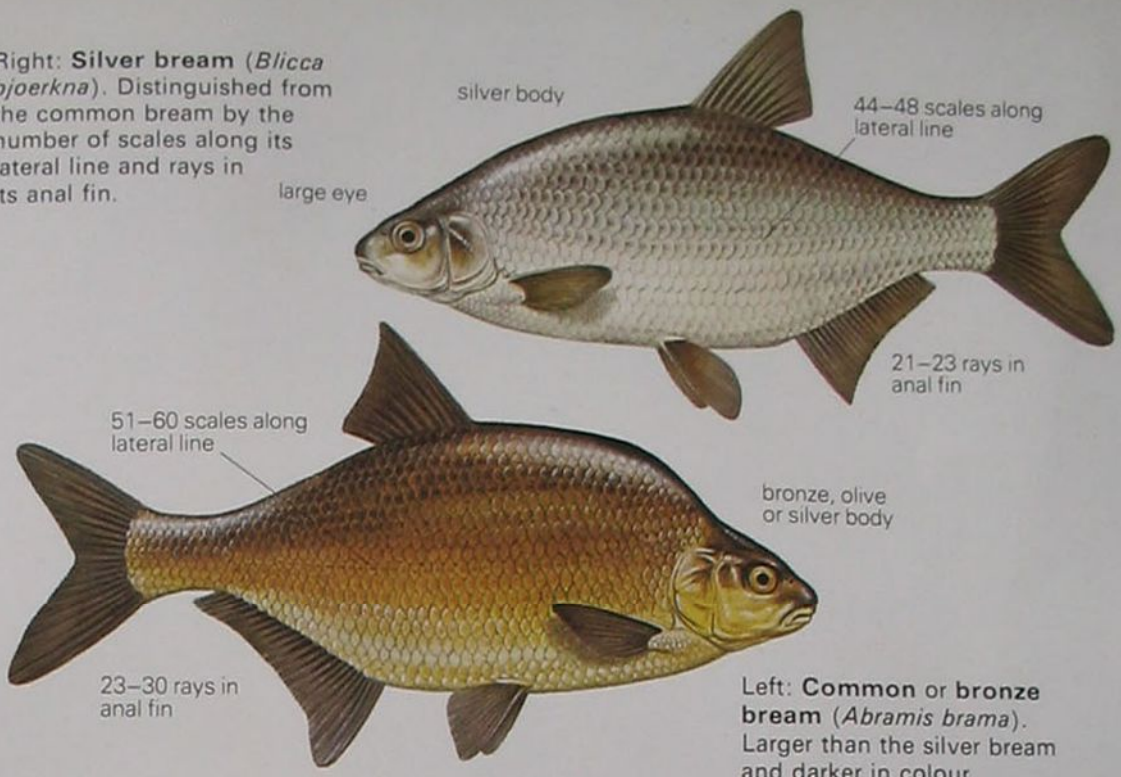
Shoaling allows the bream to patrol certain areas of a river or lake as a 'home range'. They feed mainly on bottom-dwelling invertebrates such as snails that live within their territory. They locate their food by rooting about in the mud, a technique that releases clouds of particles into the water. In clean rivers like the Thames, you can often see large muddy patches at the surface, indicating a feeding shoal of bream. The fishes often betray their presence by breaking the surface with their dorsal fins and tails.

Feeding usually takes place early in the morning, though it sometimes carries on into the day and even the night as well.

Shallow spawning sites Shoal behaviour is most prominent at spawning time, when vast groups of bream gather prior to breeding.

Above: The common bream is indigenous to southern and eastern England, though it has been introduced to Wales, Scotland and Ireland. The silver bream, being less tolerant of fast water, is mostly confined to East Anglia.

Right: **Silver bream** (*Blicca bjoerkna*). Distinguished from the common bream by the number of scales along its lateral line and rays in its anal fin.


silver body
44–48 scales along lateral line
large eye
21–23 rays in anal fin
51–60 scales along lateral line
bronze, olive or silver body
23–30 rays in anal fin

Left: **Common** or **bronze bream** (*Abramis brama*). Larger than the silver bream and darker in colour.

Below: The bream is the typical fish of weedy slow-flowing lowland rivers and canals, such as this disused canal, which is noted for its shoals of spawning bream. Man-made lakes and reservoirs and especially gravel pits often contain huge shoals of this fish. Another good place to find bream is country lakes of the type built by Capability Brown and other 18th century landscape designers.

Spawning takes place in late May when the temperature of the water has reached 14-16°C (57-61°F). The favourite sites are weed-beds in sunny shallows.

Before spawning, the males develop hard growths called tubercles on their heads and bodies, and they take up a territory, typically a piece of weed-bed about 2m (6ft) long. They can be there for anything up to a week before the females arrive.

Spawning normally occurs at dawn or dusk. The females are driven into the weeds by a group of males, and chased around and in and out of the weeds. This physical buffeting and the friction of the weeds, together with the males' tubercles, combine to draw out the females' eggs, which are then fertilised by milt from the males. Being sticky, many eggs adhere to the weeds, but some fall to the bottom of the river or lake, where they often die from a lack of oxygen.

The female bronze bream is very fecund and can produce 90,000 eggs per kilogram (40,000 per pound) of her body weight. The eggs hatch in five to six days at 16°C (61°F), the larvae at first being only 4-5mm long. They stay on the weeds (or wherever the eggs settled) for a few days while they absorb their yolks, but they soon have to find food in large quantities. The young larvae feed on diatoms and zooplankton, and grow fast.

Growth rates. The rate at which bream grow depends to a great degree on the environment, particularly on the number and size of other fishes present and on the productivity of the water. At the end of the first year, an average size for a bronze bream is 5-6cm (2-2½in).

The ultimate size of a bronze bream and its long-term growth rate depend on the type of water and the levels of predation and egg production. In lakes of 10 hectares (25 acres) or more bream can grow to be very large and very old. Fishes aged more than 20 years have certainly been recorded and they may survive for much longer than that; the biggest bream caught in British waters weighed over 6.5kg (14lb). In small waters, however, bream tend not to grow as large, and a specimen weighing 1-2kg (2-4½lb) would be considered fairly big.

The bream is one of our most popular freshwater angling fishes, and it can be caught in great numbers if an angler contacts a large shoal in a feeding mood. Much harder is the catching of a very large bream. An angler may fish for a lifetime and never see a 5kg (11lb) bream, and those who do will probably have fished for hundreds of hours to catch it.

WONDERFUL WALNUTS

Walnut trees are no longer grown in Britain for their nuts and timber, as they used once to be. Today, they grace many a park and country garden.

No one is quite sure when the walnut tree was first introduced to Britain, although the ancient Romans very likely tried to establish it here for they were extremely fond of the nuts.

However, we know that walnut trees were definitely established in Britain by the end of the 15th century because they were mentioned in the literature of the period as growing in orchards, paddocks and gardens. There used to be large groves of walnut on the North Downs in Surrey, particularly around Godstone, Carshalton and Leatherhead, but these have now all but disappeared, having been cut down for their valuable timber. As well as being a popular wood for furniture-making, walnut was long used for making musket butts and large numbers of trees were cut down for this purpose during the Napoleonic Wars at the beginning of the 19th century.

Today, walnut is no longer planted on a large scale for commercial purposes but many fine specimens can still be seen growing in parks and gardens. It grows best in the southern counties of England, where it is not unusual to see walnut trees that have 'escaped' and are growing wild in hedgerows or copses. These were probably spread there unwittingly by rooks and jays, both of which quickly rob a walnut tree of its fruit and then drop or bury the nuts.

Distinctive bark The walnut tree owes much of its beauty to its distinctive bark. This is a very pale grey, with age becoming rugged and deeply scored by a criss-cross of furrows.

The trunk is usually short, dividing fairly low down into stout twisting branches. The crown is large and rounded.

The twigs are similarly stout and resemble those of a horse chestnut. In winter they carry small black buds arranged alternately along their length. Below each bud is a conspicuous semi-circular scar where the previous year's leaf was attached.

The buds burst into leaf early in May. When they unfurl they are a fresh olive-green colour, sometimes tinged with red. Their colour changes to a yellow-green with yellow veins as the leaf matures, and then fades during the autumn to a drab dark brown.

The leaves of a walnut tree are compound, consisting of five to nine leaflets attached to a central stalk – an arrangement known as pinnate. Each leaflet is leathery and smooth-margined – the common walnut is the only tree in the walnut family in which the leaves are not toothed. The leaflets are arranged in opposite pairs on the leaf-stalk, with one larger leaflet at the end.

Wind-pollinated flowers The walnut blossoms at about the same time as it comes into leaf, or in some years slightly earlier. Both male and female flowers are borne on the same tree, the females near the tips of the branches on the new season's shoots and the males further back along the branches on last year's shoots.

Opposite: Stout branches rising from a short trunk to a large spreading crown give the walnut tree its typical shape. Many fine specimens can be seen growing in Britain's parks and gardens.

Right: The flowers of the common and black walnut are similar to each other but the leaves and fruits show distinct differences.

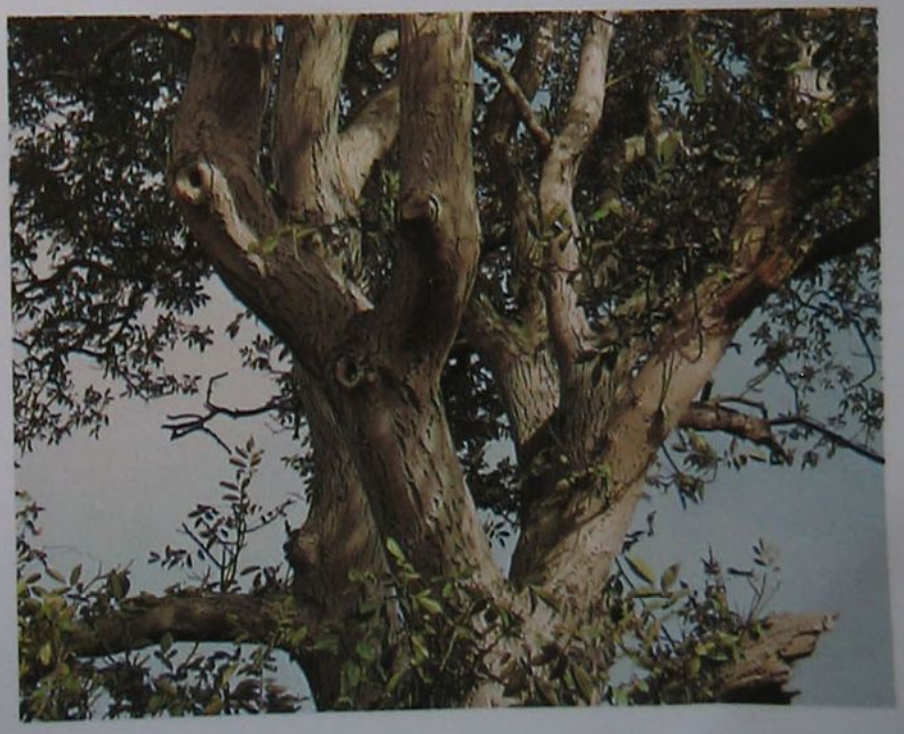
Common walnut (*Juglans regia*). Deciduous tree, native to south-east Europe and Asia from Turkey to the Himalayas. Height to 25m (80ft).

Black walnut (*Juglans nigra*). Deciduous tree, native to eastern and central North America. Height to 30m (100ft).

The male flowers are greenish catkins, about 5-10cm (2-4in) long. The female flowers are borne in clusters of two to five. They sit on short stalks and are green flask-shaped structures about 1cm (½in) long, each topped with two purple pollen-catching stigmas.

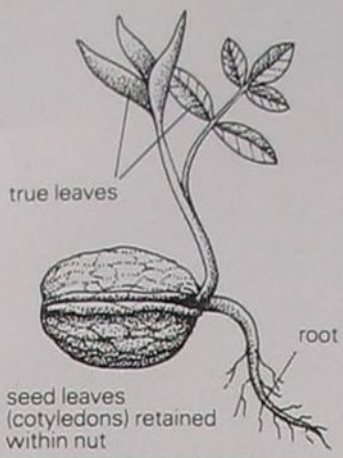
Walnut fruits After fertilisation the female flowers develop rapidly until, by the end of June, they have swollen into green oval fruits about 5cm (2in) across. Inside each fruit is the familiar walnut, with its wrinkled flesh enclosed in a shell. Early in the summer the shell is still soft and at this stage, with the nuts still intact, they can be pickled and

Below: The pale grey, almost white, bark of the common walnut is one of this tree's most distinctive features. On young trees the bark is fairly smooth (as here) but with age it becomes deeply fissured.



Inside a walnut

The wrinkled 'brain-like' part of the walnut—the part we eat—is the embryonic cotyledons or seed leaves. When a walnut fruit matures the skin splits to release the nut (far right). This falls to the ground and, if the nut germinates, the seedling shoot and root emerge and grow, fuelled by food stored in the cotyledons inside the shell.

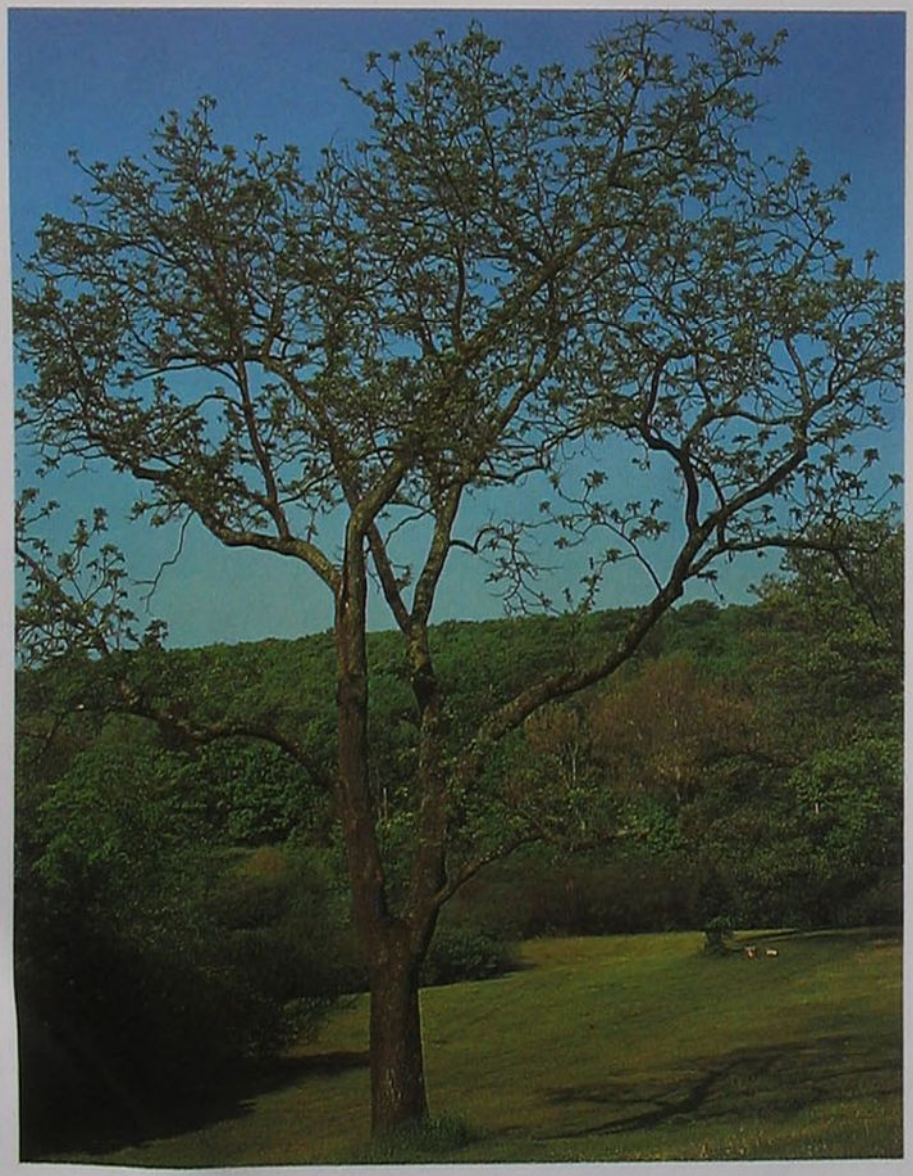


Below: A black walnut just coming into leaf. This species has a darker bark and timber than the common walnut (hence its name) and is much less frequently encountered in this country. Yet it is the faster-growing of the two and it reaches a greater height. Both species grow best in the south of England.

steeped in vinegar with spices and seasonings. The result is delicious pickled walnuts.

If left on the tree the nuts continue to ripen. The green outside casing turns brown and then shrivels and splits open to reveal the nut inside. This usually happens by the beginning of October.

In Britain, walnut trees cannot be relied upon to produce a good crop of nuts, a late spring frost often killing the flowers and with them any chance of a crop. The best crops are collected in south-eastern England, where the climate is most favourable. But the majority of walnuts sold in this country come from France or Italy where the trees fruit freely.



Veneers for furniture Although the chief value of the walnut in Europe is as a fruit tree, it is also a very important source of timber which, being light yet durable, is highly valued in furniture-making. The grain is coarse but it shows beautiful whorled patterns in shades of brown. Walnut wood is rarely used solid for furniture-making. Instead, a piece of furniture is built from ordinary timber and then covered with wafer-thin veneers.

The timber's toughness and resistance to shrinkage made it ideal for musket butts in the past, and it is still used for the butts and stocks of fire-arms today.

Pigment for staining The characteristic brown tones of the timber are due to the presence of a special pigment, which is also found in the bark, leaves, twigs and fruits.

The leaves have a pungent fruity smell. Fishermen were advised to boil the leaves with water and sprinkle the resulting concoction over the ground—apparently, there is nothing like it for bringing worms to the surface. But the most extraordinary use for walnut leaves was recorded by John Evelyn, the distinguished 17th century diarist. He wrote that 'A distillation of the leaves with honey and urine makes hairs spring on bald heads!'

The black walnut The tree commonly known in Britain as walnut is only one among several species belonging to the walnut genus, *Juglans*. Among the other species, only the black walnut is at all common in this country.

The black walnut was introduced to Britain from North America during the 17th century. Its name comes from the fact that its timber is a rich dark brown colour. The main differences between it and the common walnut are that it has reddish-brown twigs, leaflets that are toothed—with a great number of them to each compound leaf—and bark that is dark brown or black. Its nuts are inferior to those of the common walnut, being much smaller and with a rather bitter taste.

LIFE ALONG THE RAILWAY TRACKS

From the carriage windows of a train there's always the chance to see some wildlife – whether it is curlews and shelduck on the glistening mud of Poole Harbour, a glimpse of fallow deer in the New Forest, or seals basking on the sandbanks of the Tay.

Above: A single line track at Fawnhope (Hereford & Worcester) with a shrub-covered embankment. The plants do not seem to suffer from the passing of trains and act as hosts for a wide variety of animal life.

It is now perhaps too late for anyone to produce a field guide for train-borne naturalists – a book which would tell them what might be seen from the carriage windows. The post-war years, which have seen the great upsurge of popular interest in Britain's wildlife, have also witnessed the decline and mutilation of its railway system.

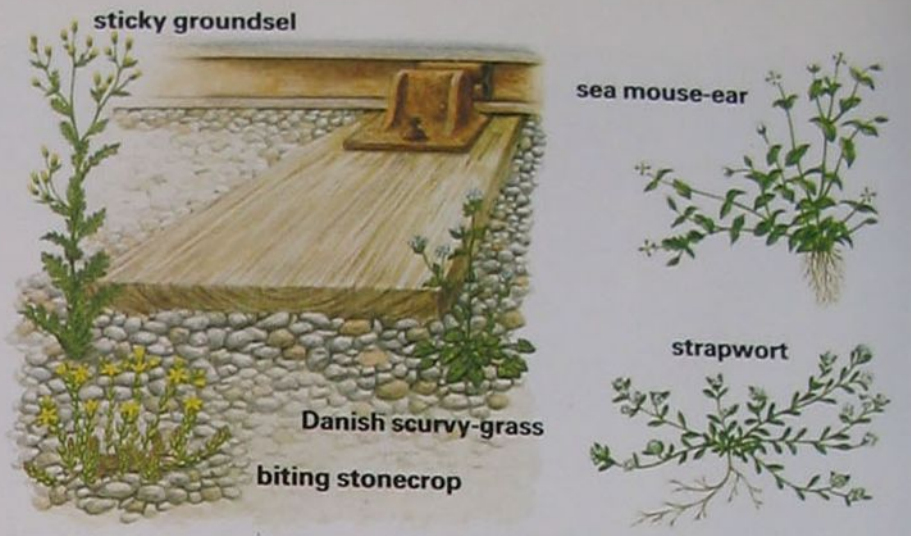
Conditions were very different in 1904, when the first edition of Stanford's *Geological Atlas* appeared. This admirable book devoted a chapter to 'descriptions of the geological features observable along the main lines of railway'. It explained the scenery through which the passenger was travelling, named the rock strata so conveniently exposed in the railway cuttings, and drew attention to the brick-yards, quarries, gravel-pits and collieries along the way. It also gave its readers occasional snippets of palaeontology – that here the London, Tilbury and Southern Railway was crossing the terraces of Pleistocene gravel which had yielded the remains of mammoth, hyaena and hippopotamus, and that the magnesian limestone by the North-eastern line, to the south of Durham, was noted for its fossil fishes.

Many of the old lines referred to in Stanford's atlas, let alone their original names, have passed into history, but it is still true to say that no-one with an interest in geology or any other branch of natural history need ever be bored when travelling by train – provided,

of course, that the journey is made in daylight and above ground. It is surprising perhaps that the promoters of British Rail, in stressing the advantages of their method of transport over the use of the motor car, have not publicised the fact that from their carriage windows you can spot curlews, oystercatchers, herons and shelduck on the glistening mud of Poole Harbour or the Devon estuaries, and have more than a fleeting glimpse of the fallow deer in the New Forest, the soaring Welsh buzzards, or the seals that bask on the sandbanks of the Tay.

Plant sanctuaries Just as the railways have a good deal to offer observant naturalists, so they have also been of benefit to Britain's wildlife. The relatively inaccessible embankments and cuttings can be sanctuaries for plants which have long since vanished from the neighbouring land through urban expansion, industrial development and changes in farming methods. Sutton Park in the West Midlands now retains the only sizeable examples of heathland to have survived the growth of Birmingham and its Black Country satellite towns, but you can still find heather on some of the suburban railway banks of Solihull and Sutton Coldfield. Primroses and cowslips, which have been brought to the edge of extinction in many parts of the countryside, can also flourish on railway banks, the primroses often making a brave show in the built-up areas, as anyone who has made an April journey from London to Brighton can testify.

Cow parsley, gorse and broom, bluebells, harebells, foxgloves, knapweeds and willowherbs all add their colours to railway lines in the appropriate season, and naturalised garden plants can also make a significant contribution to the railway flora, especially around towns. Lupins are much in evidence around Birmingham, and bladder senna, which was first planted deliberately on London's railway banks, is now able to spread there without human assistance. Beside the track there are beds of horse-radish, pink blankets of soapwort, yellow stands of golden rod, lurid splashes of everlasting pea, patches of Michaelmas daisies, thickets of butterfly-attracting buddleia and tall forests of the all-too-successful Japanese knot-weed.



Above: Bladder senna, once planted on London's railway banks, now spreads by itself.

Below: Any lake, pond or gravel pit you see from a train is likely to be frequented by swans and other water birds.

Birds, insects and reptiles Recognising the larger birds from carriage windows is relatively simple, especially when an embankment gives the observer an elevated view of the countryside. The range of vision is more restricted in the cuttings, but even here the odd snatch of bird song may betray the presence of a robin, chaffinch or willow warbler. At one time, too, the railway cuttings were a favourite haunt of the red-backed shrike, now a bird that is very rare in the British Isles.

Some of the more obvious butterflies can be identified from the train. It would be hard to miss a male brimstone or a male orange-tip, and if the train should make an unscheduled stop beside some waste ground, the passenger-naturalist may be compensated for the delay by the sight of a buddleia bush laden with peacocks and small tortoiseshells. In the south of England one trackside insect might even be *heard* from the train: Dr David Ragge, Britain's foremost authority on crick-

Left: Not so easy to see from a train are the plants growing on the track itself—an inhospitable ribbon of stony desert between the rails which can only be colonized by low-growing species able to withstand dry conditions and extremes of temperature. Some are more usually found in maritime habitats. They include biting stonecrop, sticky groundsel, Danish scurvy-grass, sea mouse-ear and strapwort. Danish scurvy-grass is one of the coastal plants which have been brought inland with shingle ballast, and has been recorded at several places between London and the Midlands. Strapwort has only one truly native locality—Slapton Ley in Devon—but it has been found along inland railway lines.

ets and grasshoppers, has picked up the loud, high-pitched 'song' of the great green bush-cricket from inside the Cornish Riviera express.

It is not possible to see any reptiles from the window-seat, but their presence has been confirmed by those few naturalists who have been allowed access to railway property. Slow-worms have often been found, and the dry banks and track-ballast make ideal basking places for adders and common lizards.

Mammals The small rodents which form part of the adder's diet can also find a home by the railway. Wood mice and short-tailed voles can even inhabit urban railway banks. The brown rat is also found and must be just as common a railway resident in farming country as in town. It is no wonder that we so often see a cat lurking in the long grass along the tracks.

Rabbits, which may also fall victim to the stalking cat, are more in evidence than most mammals because of their size, abundance and the fact that, although they are more active at night or in the twilight, they will show themselves in daylight if undisturbed. Evidently they do not regard the noise of a passing express as disturbance. Rabbits are largely responsible for the holes seen in the railway banks, but the larger excavations are the work of foxes and badgers which also take advantage of these well-drained sites. They are beyond the reach of most human beings and there is plenty of food available. The foxes have received a lot of publicity, and for many commuters on their way to town, the sight of a vixen sitting with her cubs in the sunshine has made a pleasant start to the working day. The scene has been captured more than once by press photographers.

Above: A profusion of plants has sprung up among the rails in this shunting yard, in a little used area. In the foreground is rosebay willowherb (the tall pink spikes), and spear thistle, and in the background are a few specimens of the most famous train-travelling plant of all—the Oxford ragwort. A botanist has recorded seeing a few of the winged fruits of Oxford ragwort float into a railway carriage near Oxford and drift out again just before Reading station.

Below: Rabbits appear to be quite at home along railway tracks—apparently not regarding the trains that thunder by as a disturbance! They will even come out near the tracks to feed in daylight.

Migration routes Human beings are not the only living things to have used the railways for getting about. The railway banks are green corridors running into our cities from the surrounding countryside, and there seems little doubt that foxes and rabbits have used them to penetrate the built-up areas. It can explain the occurrence of wild rabbits in the Princes Street Gardens, alongside Edinburgh's most famous thoroughfare, and account for their former presence on waste ground within five minutes' walk of Southampton's main station. Foxes can now make the occasional appearance in Central London, even at such unlikely places as Waterloo, Blackfriars and Trafalgar Square.

Railways have also influenced plant distribution. The tiny spores of ferns and the plumed seeds of many flowering plants may travel many miles in the slipstream of a moving train or suspended in the air within the train itself. Ferns have colonized the damp brickwork of stations, bridges and tunnel entrances, and in the days of steam the conditions were particularly favourable for the

early stages of their development wherever locomotives were frequently halted by signals. Some ferns made their appearance far beyond their natural range in Britain. The brittle bladder fern is essentially a plant of the rugged north and west, especially Scotland, Cumbria and Wales, but the trains took it to the English lowlands of the east and south-east. Another western fern which the railways have helped to spread eastwards is the rusty-back, an attractive plant with rust-red scales on the underside of its fronds.

The plant most celebrated for this method of dispersal, however, is the Oxford ragwort. This species is a native of Sicily and southern Italy, where it grows on volcanic ash. It was first recorded growing wild in Britain in 1794, on the walls of Oxford, to which it had apparently escaped from the Botanic Garden. It seeded itself by the Great Western Railway at Oxford around 1879, and then began its remarkable spread across the country, reaching Reading before 1896 and the fringes of London by the turn of the century. Its appearance in Wales, at Cardiff in 1898, may have been due to a direct introduction from southern Europe via the seaport, but it seems more likely that the seeds were carried inside a railway carriage from Swindon, where it was already well-established.

We can be quite certain that insects, spiders and other invertebrates have also been carried by passenger trains, as stowaways in the luggage van or through being sucked in through the windows, but rail transport is unlikely to have been a major factor affecting their distribution. During World War II, however, it was thought likely that London's Underground trains were responsible for the limited spread of the culicine mosquitoes found breeding in the water that collected under the platforms and elsewhere. These insects added considerably to the discomforts of the many Londoners who were using the tube stations as air-raid shelters. The only animal passengers now making much use of the Underground, apart from human beings and their dogs, are the street pigeons (feral rock doves) which forage on the platforms on the Inner Circle and are occasionally seen taking a tube train to another station. The noise of the trains passing by does not seem to disturb them at all.

Above: Take a spring railway trip through almost any part of England that is wooded and you may be rewarded by the sight of a mass of bluebells in flower. The land around railway tracks is usually left undisturbed, thus allowing the plants to flourish.

Below: Look out for fallow deer grazing in the open. Although the trains may startle them at first, it seems that the deer soon learn to ignore them.

AGGRESSIVE WATER SHREWS

If you hear intermittent, high-pitched squeaking and twittering from the grass as you walk along a river bank, the chances are that the noises are not made by a cricket or bird but by a water shrew that is probably engaged in some aggressive act.

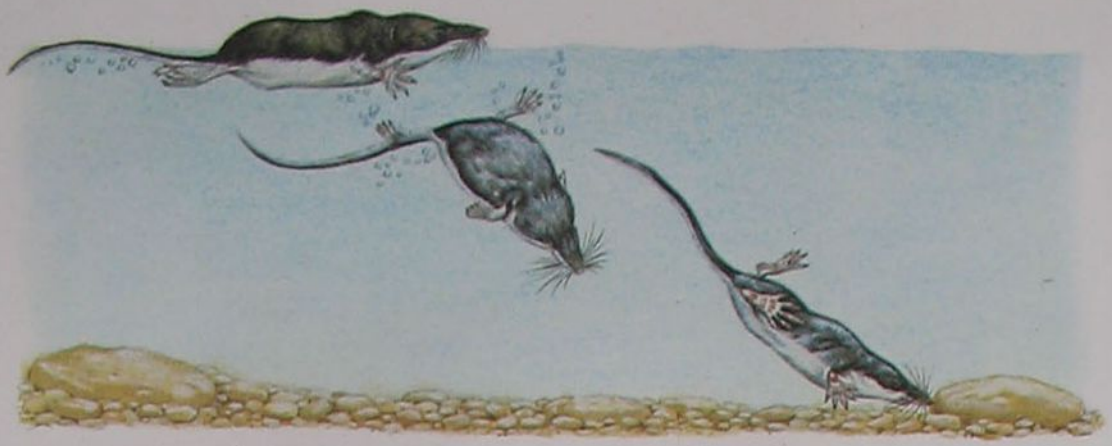
Water shrews have many predators including foxes, stoats, weasels, kestrels and owls. Pike and perch eat them too. Domestic cats kill but then do not always eat them, because of their strong musky smell.

Water shrews are one of the five species of shrew found in the British Isles, and they differ from the others in several ways. They are the largest, at almost twice the weight of the common shrew and four times the weight of the pygmy shrew. Even so, they weigh little more than a 50 pence piece. In addition, water shrews have rather long fringes of greyish hair on their tails and on the edges of their hind feet, whereas other shrews have shorter fringes on their feet. Their coats are glossy black above and greyish, sometimes white, below.

Watery habitat The water shrew is widely distributed and has been recorded over most of mainland Britain, on the Inner Hebrides, Hoy in the Orkneys and the Isle of Wight. As their name suggests, water shrews are at home in water. They usually live close to a stream, pond or slow flowing river, preferably where there is good cover. They are secretive and shy, and hide from larger mammals and birds.

Wherever they are, water shrews establish a territory where they make a system of runways and tunnels. Dr Peter Crowcroft, who did much of the pioneering work on shrew biology, categorised these areas into three types: surface runways which enable the shrew to travel about swiftly; surface burrows which are used for finding food, rather like a mole's burrow, and extend through the grass in a great maze, connecting with the underground tunnel systems; and tunnels, used for

The diving water shrew



WATER SHREW
(*Neomys fodiens*)
Size Body up to 9cm (3½in), tail up to 7cm (2¾in).
Colour Dark, almost black, above, may have brownish tinge; usually pale beneath.
Breeding season Usually April-October.
Gestation About 24 days.
No of young 3-8, with 2-3 litters a year.
Lifespan 2-18 months.
Food Invertebrates underwater as well as on land; small fish, frogs which are paralysed or killed by a venomous saliva.

nesting and for access to the water. Water shrews can dig very effectively, using their snouts as well as their feet. They will not tolerate other shrews in their territory–pandemonium breaks out if a stranger ventures in by mistake, but they share the burrows of voles and moles.

Shrews remember the geography of their burrows and runways in great detail, unlike many other mammals which rely on scent markings to direct them, so that by the time they have run through a burrow for a second time they travel on 'auto-pilot'. If an obstacle is removed from their path, like a clump of grass or a root, they negotiate as though it were still there. Conversely, if an object which other mammals might avoid, such as a prickly sweet chestnut, falls into a runway, shrews will run headlong into it.

The coat of the water shrew is very water repellent, and the shrew floats high like a cork. As it dives, the fur traps a film of air bubbles, and the relatively large amount of trapped air compared with its weight makes it awkwardly buoyant. With fast, frantic strokes of its feet it scrabbles to the bottom in search of food. It has to paddle all the while it noses around the stones and weed because the moment it stops, it will shoot up to the surface again.

Agile movers The fringes of hair on the water shrew's tail and hind feet help it to propel itself through the water. The feet give extremely good grip which is useful for overturning stones at the bottom and in tree climbing. Water shrews are versatile animals and are not restricted to aquatic and ground habitats. When they locate an insect in a tree or bush, they climb after it. If required they can also use their tails to grip twigs or branches.

All small warm blooded animals need to work hard to maintain their body temperatures in a climate like that in the British Isles. Water shrews forage intently to eat enough to sustain the high metabolic rates which dominate their short, active lives.

Their body temperature is about the same as our own, but they have to work about twenty times as hard to maintain it. A shrew may eat just over its own body weight in 24 hours. As they do not hibernate, it is hardly surprising that they seldom live more than 18 months at a maximum. Constant high activity places enormous demands on the heart and circulation.

Touching food No one has described the way shrews find their food better than Crowcroft: 'When first one watches shrews feeding, one is struck by their inability to find food until they almost fall over it.' This may seem surprising in view of the shrew's apparently well developed snout. Smell and sight are important, even though shrews are extremely short-sighted; but touch is paramount in the search for food, although it can lead to disaster. The shrew's fast reactions help it to escape easily from some of its more dangerous encounters. When a water shrew meets a mole in its tunnel system, the mole barely has time to flail out with its legs before the shrew is on its way.

Aggressive habits The word 'shrewd' derives from 'shrew' and originally meant villainous before its present day meaning evolved. Water shrews are possibly the most aggressive of all the shrew species and will not tolerate the presence of other shrews, regardless of their

age, sex, or species. Serious fighting, however, is minimised by a strict set of rules.

If one shrew meets another in a runway the intruding shrew usually backs off fast and scurries away. If the stranger will not withdraw the two engage in a squeaking and screaming contest where the one who screams longest and loudest causes the other to give way. The fight escalates if this does not resolve the dispute.

The first stage of water shrew aggression involves swift biting of the opponent's tail. The second stage of this trial of strength is continued screaming with one or both animals rearing up on their back legs. This sudden increase in apparent size, and the flashing of white belly fur on some animals usually settles the argument, but flashing may continue for several seconds.

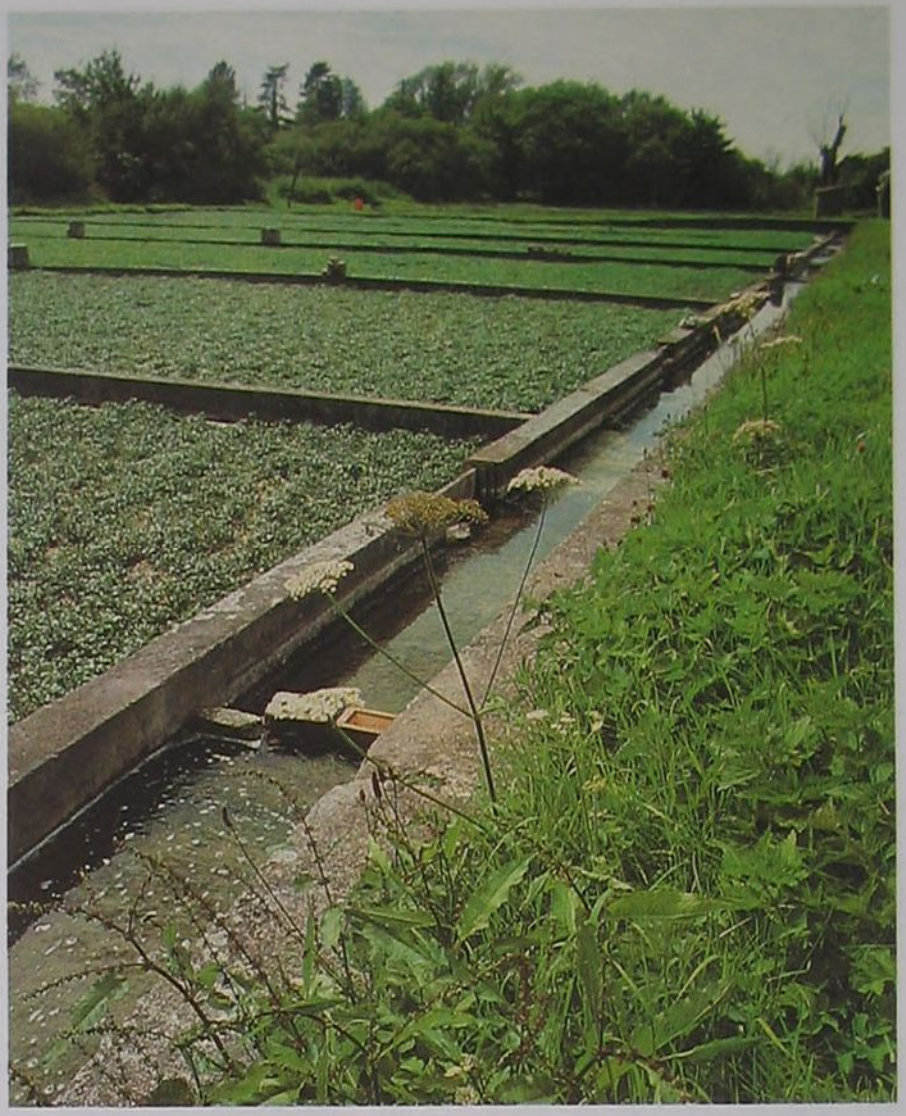
During the third stage of agonistic behaviour the shrews grip and grapple with each other with an increasing lack of mercy. The last resort is for the shrew to fling itself on its back, striking out with its legs and screaming at the top of its voice. The effect on the opponent is devastating, but can be lost if both act together because neither can see what the other is doing.

Research has shown that the order of these stages of aggression is extremely strict. Each stage is more energetic than the last, so by trying one stage at a time the chances are that the fight will break up sooner rather than later, unless the two are very evenly matched. That way not too much energy is wasted.

Blind alley nests Nests are made within the burrow system, also according to a strict procedure. The shrew collects grass and other soft fibrous materials which it dumps outside the nest chamber, a blind alley off one of the burrows. It squeezes into the chamber, drags the material inside, then turns round in circles, gradually releasing its grip on the grasses. The resulting hollow ball is then strengthened with further building work.

Shrews use their nests to rest for short periods and to raise their young. The peak breeding season is late May and June. Pregnancy lasts about three weeks, and the young are born blind and hairless. A water shrew's nest should never be disturbed: the young will quickly chill and the mother may bite the intruder. Each baby weighs about the same as a halfpenny piece at birth. After five weeks they reach full size and are unceremoniously ejected from their mother's territory. An early litter may breed the same year, but the majority do not. Many first year shrews perish in their first winter: the twin blights of cold and starvation are against them. Predators also take their toll.

Young shrews moult in October, growing a thicker coat before winter sets in. Shrews do not hibernate since their metabolic makeup does not allow it. Their parents will be lucky to live until December, as they do not grow a winter coat the second time round. Their teeth have worn down to stumps and the cold catches up with them. Maintaining their almost incessant activities, which include diving into near-freezing streams, becomes too much, and they usually die of starvation. Meanwhile the next generation will be scurrying around their runways and burrows; the only clue they are there is their high pitched twittering and squeaking.



Above: A watercress bed on the Itchen at Alresford in Hampshire, a typical habitat of water shrews.

Below: Water shrews eat invertebrates like earthworms, as well as frogs, small fishes and plant material.

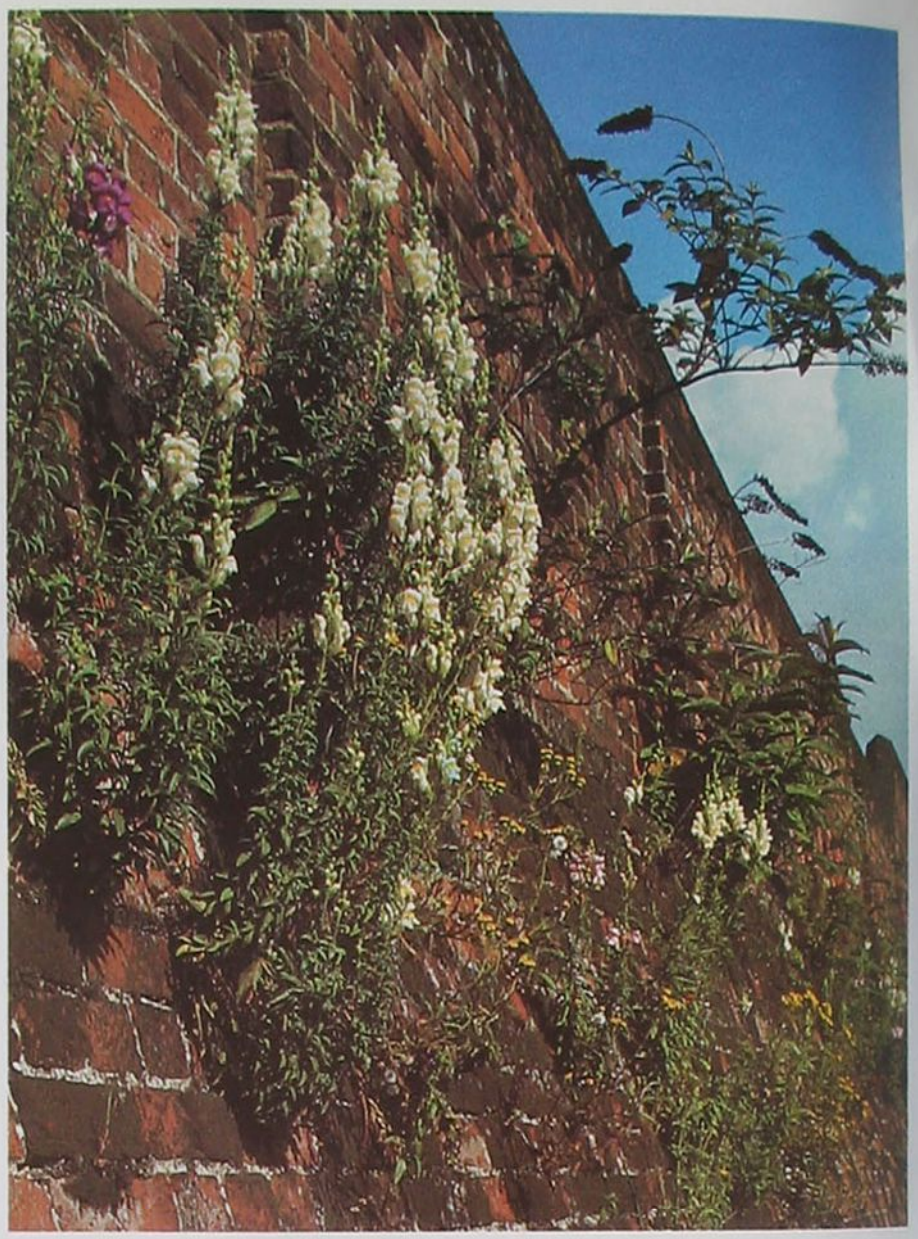
SPURRED SUMMER FLOWERS

The colourful and distinctive flowers of snapdragons and toadflaxes appear in summer in a variety of habitats, ranging from walls to sand dunes.

Snapdragons and toadflaxes belong to the figwort family where they form a group of genera, known as a tribe. They are distinguished from other figworts primarily by the way in which their seeds are released. Figworts have seed capsules which split downwards from the top to release their seeds, while the snapdragon tribe have capsules which open at the top with two or three circular pores.

There are about 300 species of the snapdragon tribe worldwide, most of them growing in the north temperate regions; the toadflaxes form the largest group within the tribe. Only a handful of species occur in the British Isles, and many of these have been introduced, either accidentally or deliberately as garden plants. They are, perhaps, most familiar from the characteristic way in which the flowers open when the sides of the flower tube are squeezed, snapping shut when released–hence the name snapdragon.

Seed statistics The seeds of snapdragons and toadflaxes are small, mostly less than 1mm in diameter, and they are released in a similar way to the 'pepper-pot' mechanism found in the poppy. When breezes buffet the plant, the seeds are shaken out a few at a time through the pores at the top of the capsule. They fall about a metre (39in) away although a strong wind, capable of picking up particles of dust and grit, can easily lift the seeds and disperse them over considerable distances.



Above: The common snapdragon (*Antirrhinum majus*) often colonizes hot and dry places such as walls, derelict buildings, railway ballast and sand dunes.

Below: The deeply spurred flowers of the common toadflax (*Linaria vulgaris*) bloom from July to October.

The seeds of some toadflaxes, including the common toadflax, have an encircling wing which further aids transportation by the wind.

The seed production of many species is prodigious and it has been estimated that a single vigorous plant of the introduced purple toadflax can produce tens of thousands of seeds. Given these statistics it is not surprising that, once a toadflax finds a suitable habitat, colonization is rapid.

Garden escape The snapdragon must be one of the best known garden plants, cultivated for so long and naturalised in so many parts of the world that its origins are obscure. There are about 20 wild species of snapdragon or *Antirrhinum*, most of which grow in Spain or Portugal. In southern Europe, an old house bedecked with snapdragons is a common sight, for the walls of old buildings provide a similar habitat to the rock crevices where the wild plants are normally found. In Britain, it grows wild on walls and chalk cliffs in many parts of the country.

Bricks and stones The well-known ivy-leaved toadflax takes hold on walls in the same manner, particularly where the mortar is old

and crumbling. Although widespread, this species is not native, but was first recorded in Britain in 1640, having been introduced from further south in Europe.

As its name suggests, the leaves are lobed and stalked like those of ivy. The small purple or lilac flowers have a gold or yellow palate that presents a striking contrast. Each flower is borne at the base of a leaf, but when conditions are poor and the plant is starved, the flowers appear in clusters as in other toadflaxes. This species does not grow well when transferred to gardens – the attractive flowers are lost among straggling stems reaching up to 1m (39in) in length.

Dunes and sandy soils By way of contrast to the familiar snapdragon and ivy-leaved toadflax, some of the rarest species of the tribe are found on sand or sandy soils. One such species is the native Jersey toadflax, very much a rarity in the British Isles where it grows only on sandy soils in Jersey, although it is widespread in southern Europe and the Near East. An annual, it has small, violet flowers bearing a long, slender spur, and seeds that are unusual in that the wing is repeatedly divided to form an encircling fringe.

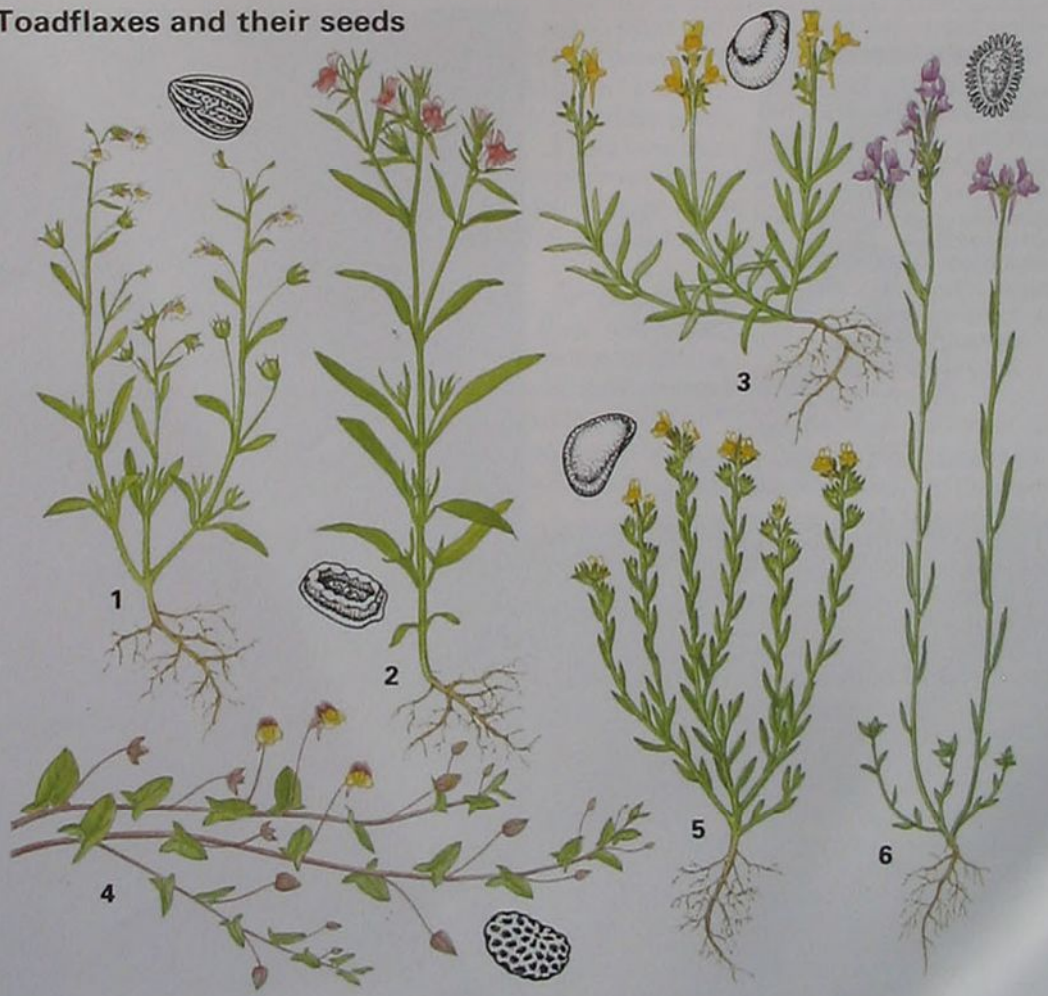
Two rare species are found on dunes and sandy soils in Devon and Cornwall. The sand toadflax is a small, sticky-leaved plant with tiny yellow flowers, and is probably an introduced species. Prostrate toadflax, larger, with hairless leaves and yellow flowers which measure up to 15mm ($\frac{3}{5}$in), may be a native species.

Arable fields and waste ground On the light, often sandy, soils of waste ground and arable fields in southern England and Wales, our two very similar fluellen species can be found. These are sharp-leaved fluellen, which is slightly more common, and round-leaved fluellen. Both species have broad, stalked leaves, creeping stems and yellow flowers with a spur and a purple upper lip. Each of the two pores of the seed capsule opens by means of a circular lid, which drops off entirely as the capsule reaches maturity.

The small toadflax, an upright annual with tiny pale purple flowers, is also found in

Above: The ivy-leaved toadflax (*Cymbalaria muralis*) is well-adapted to life on a wall. The flowers are held out from the foliage on long, slender stems so that they can be pollinated by insects. After pollination, the petals fall and the flower stalk curves away from the light, pushing the capsule into a dark crevice. The ripe seeds are shaken out of the top of the capsule. Their thick corky ridges wedge them firmly into crannies in the wall.

Toadflaxes and their seeds



1. Small toadflax (*Chaenorhinum minus*). Flowers May to October. Ht to 20cm (8in).

2. Weasel's snout (*Misopates orontium*). Flowers July to October. Ht to 30cm (11$\frac{3}{4}$in).

3. Prostrate toadflax (*Linaria supina*). Flowers June to September. Ht to 20cm (8in).

4. Sharp-leaved fluellen (*Kickxia elatine*). Flowers July to to October. Length to 40cm (16in).

5. Sand toadflax (*Linaria arenaria*). Flowers May to September. Ht to 15cm (6in).

6. Jersey toadflax (*Linaria pelisseriana*). Flowers May to July. Ht to 30cm (11$\frac{3}{4}$in).

Above: The more-or-less circular leaves of round-leaved fluellen (*Kickxia elatine*) distinguish it from the very similar sharp-leaved fluellen (*Kickxia spuria*) which has arrow-shaped or triangular leaves, with pointed lobes at the base.

Below: The flowers of the pale toadflax (*Linaria repens*) are rather broad with a short, blunt spur. They are in bloom from June to September.

arable fields and on waste ground, although it is probably most characteristically seen growing in delicate masses on the ballast of railway embankments.

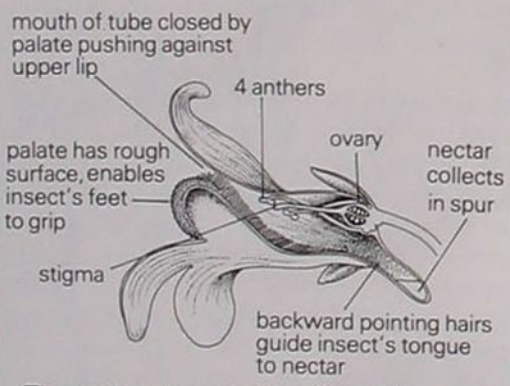
The weasel's snout, or calf's snout, is less common than the small toadflax. It is also a native species, and usually found on cultivated land. The flowers resemble those of the snapdragon, but are about half the size, dull pink, and partly concealed by the long lobes of the calyx.

Field margins and road verges Our two most familiar species of toadflax are often seen on field margins, where they occasionally grow together. Pale toadflax prefers lime-rich soils and is more or less restricted to the southern half of the British Isles. The rather small flowers, measuring up to 15mm (⅜in), are white or pale lilac with darker violet veins. The palate is sometimes yellow or orange and the spur is short and blunt.

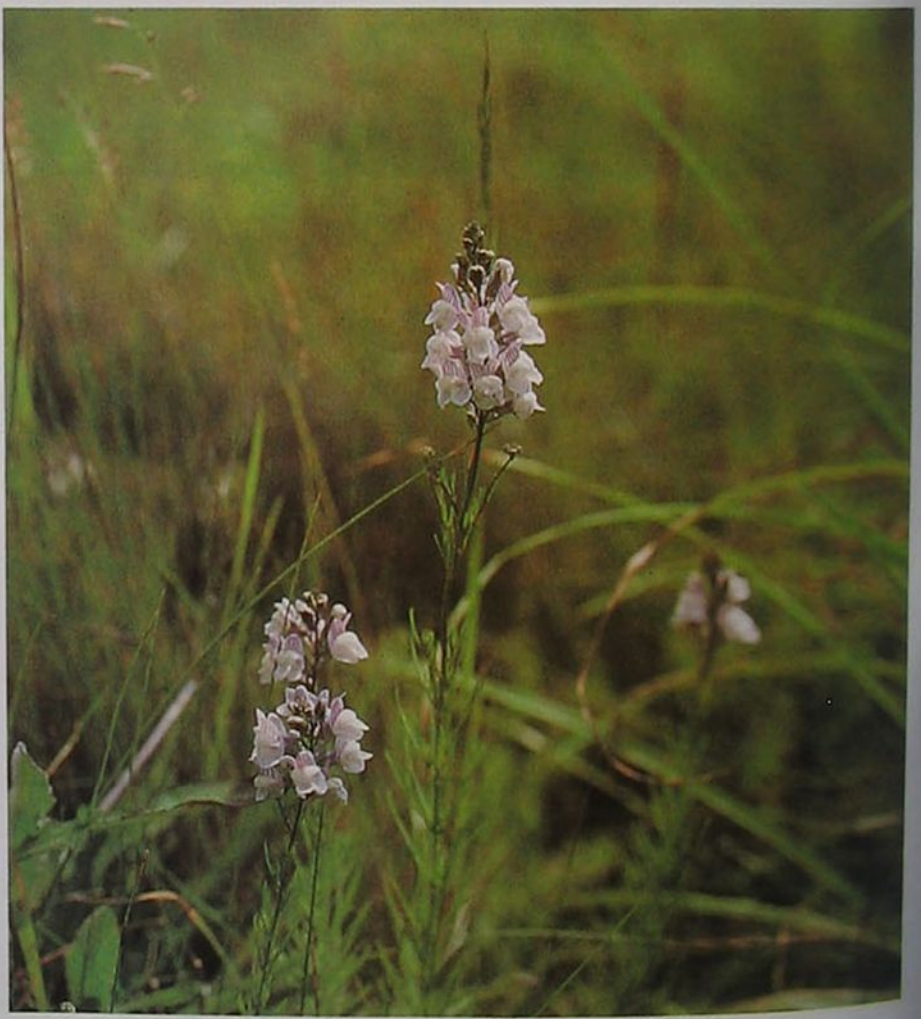
As its name suggests, the common toadflax is by far the most widespread and abundant of the toadflaxes in Britain. It is found in moist, grassy places where, like the pale toadflax, it spreads by means of underground 'stems' called rhizomes. The yellow flowers measure up to 2.5cm (1in) long and have an orange palate with a long, broad, pointed spur. In common with most species of the tribe, the flowers of the common toadflax are pollinated by bees, and the complex flower structure ensures effective transfer of pollen from plant to plant.

In spite of this complex flower structure, and the normally discriminatory behaviour of bees, pollen of one species of toadflax is occasionally transferred to the flowers of another species. Under these circumstances, hybrids are produced, and it is not uncommon to find hybrids between the pale toadflax and the common toadflax. These have dull yellow flowers, veined with violet, and appear intermediate between the parent species in other respects. Since the hybrid is partly fertile, it can hybridise again with either parent to produce a considerable range of variable plants between the two species, with widely differing colours and forms.

Inside a toadflax flower


mouth of tube closed by palate pushing against upper lip
4 anthers
ovary
palate has rough surface, enables insect's feet to grip
nectar collects in spur
stigma
backward pointing hairs guide insect's tongue to nectar

The nectary in a toadflax flower is beneath the ovary, and secretes nectar into the spur. Bees are attracted to the brightly coloured flowers and are directed to the mouth of the tube by the contrastingly coloured palate, or coloured veins in the case of the pale toadflax. The bee lands on the palate, which forms an excellent landing platform, and the weight of the insect causes the palate to spring open, revealing the mouth of the tube. The bee forces its head into the tube and probes for nectar in the spur with its long tongue. The stigma brushes against the bee's head and thorax and any pollen from a previous visit to a toadflax is transferred, while the anthers dust the bee with fresh pollen.



SINGING CRICKETS

Bush-crickets, which live mainly in bushes and among moist, low-growing vegetation, are seldom seen, though their mating songs are heard frequently in the summer.

The insect order Orthoptera, meaning straight wings, includes the familiar grasshoppers and crickets as well as the less well-known bush-crickets. All of them are able to jump some distance with their strong hind legs, and the males of most species attract the females for mating purposes by making a noise called stridulation or, more colloquially, singing. This is produced by scraping together their legs and wings, or in the case of bush-crickets, just the wings. Each of our ten species of bush-cricket has its own characteristic sound, and the females only respond to sounds made by their own species.

Life-cycle In late summer or autumn, female bush-crickets use their strong ovipositors to place their eggs in crevices in plants or soil where they remain all through the winter. They hatch the following May or June to produce worm-like larvae that rapidly shed their skins to become nymphs. These look like tiny editions of the adults, but without wings or ovipositors. There is no pupal stage, the nymphs moulting several times until the last moult produces an adult.

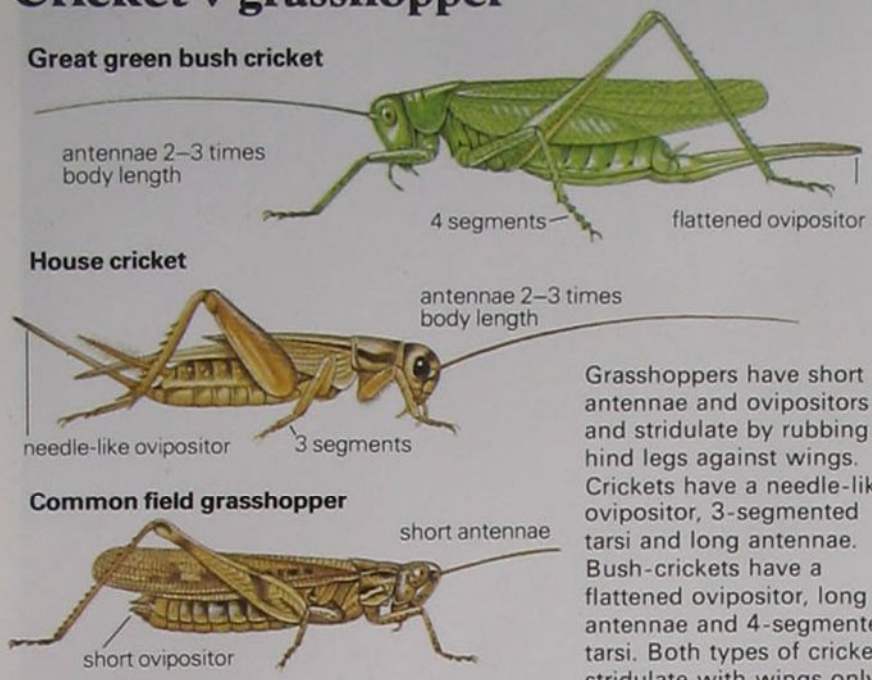
Male adults have cerci, or pincer-like appendages, on the tip of their abdomen, instead of ovipositors. Some male adults have only short wings and in females they may be virtually absent, depending on the species.

Both nymphs and adults feed on a mixture of leaves and soft insects and it seems that

Above: A male great green bush-cricket (*Tettigonia viridissima*). Being a large and rather heavy insect, the flight of this bush-cricket is poor, despite its long wings, and usually lasts for only a few metres.

Below: An older nymph of the great green bush-cricket, distinguished from the short-winged adults of some species by its wing pads, which are reversed, with the leading edge uppermost. In adults the leading edge is downwards.

Cricket v grasshopper



Grasshoppers have short antennae and ovipositors and stridulate by rubbing hind legs against wings. Crickets have a needle-like ovipositor, 3-segmented tarsi and long antennae. Bush-crickets have a flattened ovipositor, long antennae and 4-segmented tarsi. Both types of cricket stridulate with wings only.

at least some animal food is essential.

Green 'giant' The great green bush-cricket is our largest species. It is found in parts of southern England and Wales and may be quite common in warm southern coastal districts, the adults appearing from late July to September.

Measuring up to 5.5cm (2¼in) long, it is found on rough, shrubby land, where there is plenty of cover provided by nettles, thistles or reeds. It is mainly green in colour, but with a dark brown stripe down the back. The female's ovipositor, which is sword-like and nearly straight, measures up to 2.2cm (⅞in) long and she lays a total of about 200 eggs in crevices in the soil.

Like many other bush-crickets, this species lives in colonies and seldom flies or hops, preferring to run quickly down into the undergrowth if disturbed. During the afternoon and evening the males can be seen when they climb to the tops of thistles or bushes and stridulate very loudly. They produce a harsh, high-pitched sound which is more or less continuous and carries for 200m (220 yards) or more.

Tree-dweller The oak bush-cricket, most frequently seen in London suburban gardens and tree-lined avenues, is a much smaller, pale green insect, measuring 14-17mm (½-¾in) in length. It is the only British species that normally lives in trees and, in spite of its name, it is found in lime, apple, maple and lilac trees and not just oak. It is quite common in deciduous woods in England, south of the Humber, and in Wales and has also been recorded from Ireland and the Lake District.

Mainly a nocturnal insect, it prefers to walk rather than jump or fly, despite its well-developed wings. The ovipositor is fairly long and curves upwards and the female may be seen at dusk, probing the bark of tree trunks in suburban avenues for crevices in which to place her eggs. The adults, which appear in August and are comparatively long-lived, are frequently attracted to artificial light and may be found around house lights even in late November.

Oak bush-crickets are attractive insects with a fragile, delicate appearance, so that it is rather a surprise to find that, alone among the species, they are almost completely carnivorous. Their diet consists for the major part of small caterpillars, aphids and other soft-bodied insects.

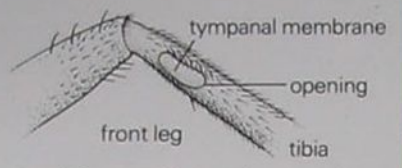
Small and speckled The speckled bush-cricket, a bright green insect with numerous tiny brown spots, is another small species, measuring only 9-17mm (⅜-¾in) long. The adults can be found in August and September in gardens, and on bushes and brambles in open woodland. They are mainly found in the southern half of England, but have also been recorded from Wales, Ireland and western Scotland.

Speckled bush-crickets are flightless, hav-

Left: A male and a larger female bog bush-cricket. There are brown and green colour forms of this species—the green form shown here is the more common.

Below: Most species of bush-cricket, like the dark bush-cricket (*Pholidoptera griseoaptera*) shown here, supplement their diet of a variety of leaves with any soft-bodied insects that they can catch.

Sound production and hearing



Male bush-crickets stridulate by scraping a thickened, tooth-bearing vein at the base of the left forewing against the thickened hind edge of the right forewing. At the base of the latter a small area, known as the mirror, acts as a resonator. Stridulation, which is usually high-pitched, can be a series of short chirps or a much longer, continuous song. The purpose of the song is to attract females for mating. Hearing organs are visible as slit-like openings in the tibiae of the front legs of both sexes. They contain a tympanal membrane which picks up sound, as do our ears.

Above: The flightless female speckled bush-cricket (*Leptophyes punctatissima*) can be identified by her virtual lack of wings and broad, upturned ovipositor.

Above: Nymphs of bush-crickets are small versions of the adults, without the wings or ovipositors which do not appear until they have moulted about five times. When rudimentary wing pads and ovipositors appear, they continue to grow until the last moult, which produces the adult; there is no pupal stage. However, in nymphs of flightless species, like the dark bush-crickets shown here, only vestiges of wings develop. Nymphs take about three months to mature—these would be adult by August.

ing no hind wings and forewings that are reduced to small brown flaps in the male, and virtually nothing in the female. The antennae and hind legs are unusually long, however; this species seems to hop more than the others. There is just enough of the males' forewings remaining for stridulating and they are able to produce short chirps every few seconds, although this is a faint sound and hardly audible more than 1 metre (39in) away.

The female has a short, broad, curved ovipositor. She places her eggs, which are unusual in being thin and oval in outline, in plant stems and bark crevices.

A common cricket The medium-sized dark bush-cricket, which measures 13-20mm ($\frac{1}{2}$-$\frac{7}{8}$in) long, is probably the commonest of the British species in England. It appears south of North Yorkshire and also in south Wales, but it is not recorded from Scotland or Ireland. It is another flightless species, with no hind wings and only just sufficient of the male's forewings remaining for stridulation. In the female, there are only vestiges of the forewings remaining.

Dark bush-crickets are most commonly found in colonies in nettle-beds, brambles and herbage alongside roads or woods—in fact, almost anywhere with sufficient cover and some light. They seem to be the least particular species in their choice of habitat, although they are not found in open fields and heaths. They sometimes even find their way into houses in the evenings.

The predominant colour of this species is brown to almost black, with a yellow underside to the abdomen. The dark colour and rather long hind legs give it a somewhat spidery appearance. The ovipositor of the female is 10mm ($\frac{3}{8}$in) long, pointed and curved upwards. She lays her eggs in crevices in bark or rotten wood. In common with the other species the eggs overwinter, but they are the earliest to hatch, from late April onwards. The adults appear towards the end of July and live until October or even November.

The males produce a brisk chirping sound, with a few seconds between each chirp and although they do this for most of the day, there is an increase in the evening. They are difficult insects to see or catch, due to their choice of shrubby or prickly cover. If disturbed, they immediately jump or crawl downwards, camouflaged by their colour.

Moorland species Most of the remaining six species are rare or uncommon, but the bog bush-cricket (*Metrioptera brachypetra*) deserves a mention as it is frequent on the moister areas of heathland and moors from southern Scotland, throughout England and Wales. In size, appearance and its brownish colour it resembles the dark bush-cricket, but the underside of the abdomen is green and there is a broad, pale band along the side flaps of the thorax. The best way to distinguish the two species is by their song which, in the bog bush-cricket consists of a continuous series of shrill chirps, without the pauses of the dark bush-cricket's song, which may last for several minutes at a time.

THE CAPERCAILLIE: A HIGHLAND GIANT

This large bird, with its unforgettable display and dramatic rivalry between males, is a great asset to the Scottish Highlands for which we should thank the Victorians, who reintroduced the species after hunters and landowners had exterminated it.

Above: A male capercaillie sings to impress a prospective mate. Capercaillies are polygamous, each male mating with several females each year. Some males are totally promiscuous, seeking females wherever they can, while others keep their own 'harems' or individual groups of mates.

A walk through a Highland forest can yield many surprises, not least of which is a glimpse of a turkey-like bird flying with considerable ease through the trees or climbing nimbly along the branches. This is hardly what one expects of a bird that weighs about 4kg (8½lb) and is about 85cm (34in) long. This is a male capercaillie, our largest and most arboreal member of the grouse family. The female is smaller, less than half the weight of the male, and about 60cm (24in) long.

The male appears at first to be a large, dark, slate-grey bird, but at close range you can see that his back is chocolate brown, his breast a glossy green and his belly and tail are marked with white. A very good view also reveals a bright red patch of bare skin above the eye. The female needs good camouflage when incubating and when guarding young, and so she is much more grouse-like than her mate. Her back is rufous, her breast chestnut-brown, while the remainder of her plumage is paler, except that everywhere, other than the centre of her breast, she is heavily barred with black.

A Highland species Capercaillies are birds of mountain forests, where there are extensive stands of trees, especially conifers, generally with patches of dense undergrowth, interspersed with more open areas of shrubs such as bilberry. Habitats such as this provide the birds with all of their food and nesting requirements. In winter the birds are arboreal, eating the buds and shoots and grazing the needles of pine trees; they are also seen in the branches of broad-leaved trees such as oak and birch. But in spring, summer and autumn, capercaillies feed closer to or even on the ground, eating leaves and berries of bilberry and similar plants, as well as grasses, sedges, mosses and occasionally cultivated grain. The

diet is thus almost entirely vegetarian, except that very young chicks, in common with chicks of most birds, feed mainly on insects, especially the caterpillars of moths and sawflies.

Capercaillies are generally viewed sympathetically by foresters, but there is no doubt that by eating shoots and needles of growing trees in spring, these birds can cause damage. In poor plantations with thinly scattered or less vigorous trees, this checks the growth of the trees noticeably, and even healthy, well-established trees need up to five years to recover completely from the damage inflicted by feeding capercaillies.

Living in flocks As a general rule, the females and young live in groups, while males are solitary birds. The chicks begin feeding themselves during their first or second day of life, but while they are small the hen still continues to brood them, after this devoting two or three months to guarding them; both mother and young have a set of contact calls to maintain close proximity during this period. As these young birds reach maturity, towards the end of their first winter, the males sometimes become intolerant of the females and expel them or form separate groups of their own. Thus a relatively large flock may separate into two, segregated by sex. A flock rarely exceeds 20 birds and usually contains less than ten.

A remarkable display Late winter signals the onset of the males' display. Initially they sing from perches in trees, and then as spring progresses they descend to the ground, where the main song and display takes place. The song consists of a number of remarkable sounds, beginning with a series of well-spaced clicks. These accelerate until they become combined into a 'drum-roll' which is followed by the 'cork-pop' sound, which resembles that of a cork being extracted from a bottle. The final phase of song involves alternating gurgling and wheezing notes. During song the male slowly walks forward with exaggerated steps in a characteristic posture, with head held high and neck feathers sleeked down, and with his tail held vertically and broadly fanned.

The main purpose of display is to attract females, and it is performed at traditional display grounds where several males may assemble. During displays they are widely separated, sometimes 100 metres apart, so that display grounds tend to be large: one that has been observed was over 1sq km ($\frac{3}{8}$sq m) in extent. The most conspicuous form of display is the 'flutter-jump', which often follows the 'cork-pop' note of the song. The male crouches or runs forward with neck outstretched, and then flies up with noisily flapping wings; he glides briefly, and then flutters back to the ground–making even more noise with his wings and often crash-landing.

In response to the sight of the leaping, gliding bird, and the sound of his calls and

Capercaillie (*Tetrao urogallus*); resident; large member of grouse family; a native species that became extinct and has been reintroduced. Length: male 85cm (34in), female 60cm (24in).

Above: The male's display appears neither dignified nor imposing when seen from the rear.

Left: A flutter-display, also known as a flutter-jump or a flutter-flight, the most splendid part of the capercaillie's courtship activity. If the heather is dense, he may fly over it in the middle phase of the display.

The spring dance

Flutter-jumps usually follow a curve round the female being courted.

crouches with neck outstretched and bill uptilted
leaps up with rapidly flapping wings
glides about 10m (30ft)
flutters down noisily
sometimes the bird overbalances on landing

wing-fluttering, the other males in the area start to perform their own displays.

Where the heather is tall and dense, the capercaillie may perform an even more conspicuous form of the flutter-jump, extending the brief glide in the middle into a long flight over the space between two bare hummocks.

Ready to fight? Another drama of the display grounds occurs when rival males encounter one another. First, their rivalry is acted out in a contest of symbolic actions–bowing and periodically raising and lowering their wings as the birds strut towards one another. Such demonstrations are accompanied by song as described above, and also by a special belching call. At times the two birds use another device to create an intimidating appearance: they arch their tails over their backs, and ruffle out the feathers on their necks, making them look dangerously thick and powerful.

If both rivals stand their ground, a short battle takes place, with stabbing, pecking bills and thrashing wings. These fights are not often to the death, but certainly there are fatalities; more commonly, the struggle is a relatively harmless one.

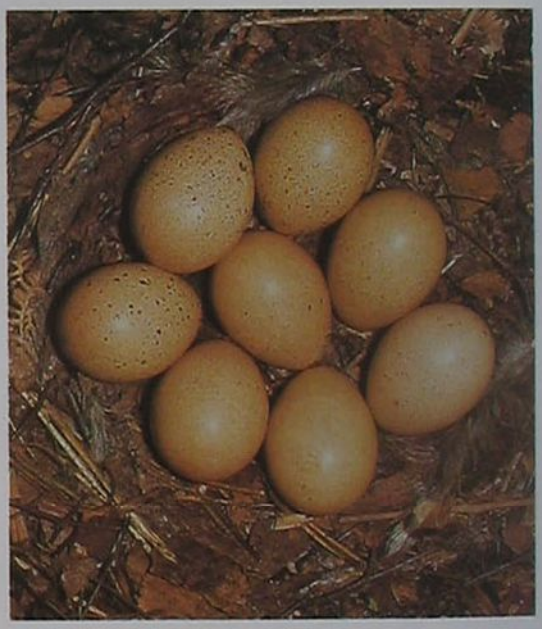
Display, courtship and copulation take place in late March and early April, and females build their nests and lay eggs from mid-April onwards. In these activities the male plays no part, even though his hens usually nest near his display ground.

Welcome back, capercaillie The life style of the capercaillie is one that relies on a very full use of the habitat: the birds need forest for winter food, shrubby vegetation for summer food and large open areas for display. These exacting needs for a home have led to a somewhat chequered history. Capercaillies used to occur in native pine forests in Scotland, Wales and Ireland, but the destruction of these forests by man led to the birds' total extinction in Britain by the middle of the 18th century. This extinction was also doubtless accelerated by hunters, who used to regard the capercaillie as a fine quarry.

Early in the 19th century, attempts were made to reintroduce capercaillies in the British Isles, but few of these attempts were successful. Efforts persisted, and various introductions from Scandinavia between 1837 and the end of the century led to the successful recolonization of suitable parts of the Highlands. The rate of spread appeared to suffer a setback as a result of the increased exploitation of timber for the two World Wars, but this largest member of our grouse family now seems well established and secure. Today, a high priority is given to conservation of the ancient Scottish pine forests.

It is somewhat surprising that the bird has not spread even further during the years following World War II, since within its present range in Scotland it has started to inhabit some mature plantations of larch and spruce; if it can do this in east and central Scotland, why not elsewhere? Perhaps we shall see further expansion as postwar plantations mature: this will be welcomed by bird-watchers and sportsmen, but foresters may have mixed feelings.

Above: In winter, hen capercaillies are usually found roosting in the branches of Scots pines and other trees. As well as roosting, they feed on buds, shoots and pine needles.



Right: Normally 7-11 eggs are laid. They are oval, cream or buff with brown or cream spots or streaks, and measure 6cm (2½in) long by 4cm (1½in) broad. During the laying period, the hen covers the eggs with grass and pine needles whenever she leaves the nest.

Below: A female capercaillie incubates her eggs. This takes around 25 days. The nest is usually a shallow depression lined with pine needles or with a little grass.

ROUND THE MULBERRY BUSH

Despite the words of the famous rhyme, the mulberry grows tall enough to be considered a tree rather than a bush. We have two species in Britain: the white mulberry–so important to the Chinese silk industry–and the more common black mulberry.

Below: A black mulberry at Stourhead in Wiltshire. The squat outline is typical of this species. Indeed, many black mulberries are broader than they are tall.

Apart from the two species of mulberry that grow in this country, about 20 others are found in various parts of the northern hemisphere, mostly in eastern Asia and eastern USA. All mulberries are small attractive trees with fleshy fruits looking rather like blackberries.

Mulberries are all members of the genus *Morus*, which in turn belongs to the mulberry family, Moraceae. Most plants in this family are tropical and, apart from the mulberries themselves, the other important genus in this family is the figs, *Ficus*.

Black mulberry This is the mulberry most commonly found growing in Britain, and it is the one most suited to our climate. No one knows for sure when it was first introduced to this country–possibly around 1500 but more likely long before that. It has been cultivated in southern Europe for untold centuries, with the consequence that its native distribution is not known for sure. Some people suggest that it was introduced long ago to Europe from China via the old trading routes. Others believe that it is a 'lost' native of south-east Europe.

Both parts of its Latin name, *Morus nigra*,

Drupe (below): Seed enclosed in a woody stone fruit, in turn enclosed in fleshy tissue.
Laburnum
Blackthorn
Pod (right): Row of seeds enclosed in a long case that splits open when mature.

refer to the colour black. The word *Morus* comes from the Greek for black, a reference to the fact that the tree's fruits change colour as they ripen from white to reddish-black. The Greeks believed that this colour change occurred because Pyramus and Thisbe died beneath the shade of a black mulberry and the tree absorbed their blood. The other part of its name, *nigra*, comes from the Latin for black.

Short and wide The black mulberry is a short tree, growing to no more than 10m (33ft) high, and is often much wider than it is tall. The trunk is short and frequently leans, and the branches are twisting, giving the tree a rugged appearance.

The leaves are roughly heart-shaped with pointed tips and serrated margins, but they can vary considerably. On very vigorous shoots, particularly those on young or coppiced trees, the leaves can be deeply lobed like fig leaves. Indeed, the leaves can be so radically different that nurserymen selling black mulberries are sometimes falsely accused of having supplied the wrong tree. One sure way of identifying a black mulberry leaf is by its rough hairy texture. On some trees the leaves can become quite large–up to 20cm (8in) long.

Above: On both species of mulberry the male and female flowers are borne on separate catkins, which appear in late spring. Male and female catkins are similar, except that the males are about twice as long; both are yellow-green and difficult to distinguish among the foliage. This picture shows a black mulberry in flower.

Below: The bark of a black mulberry is orange-brown with deep stringy fissures, though in western parts of the country it is often obscured by lichen, as here. On old white mulberries, the bark is similar, though on younger trees it is usually a dull grey or pinkish-brown.

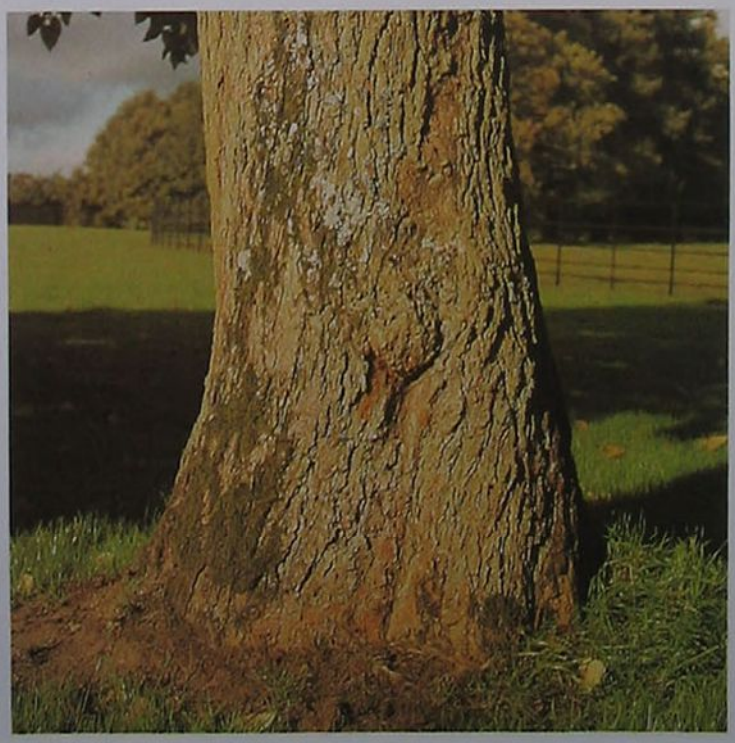
Flowers and fruits The flowers appear in late spring as small insignificant yellow-green catkins borne on hairy stalks in the leaf axils. The male catkins are about 2.5cm (1in) long and the females are half that length.

The fruits are much more interesting. At first they are green, becoming white and then orange or scarlet by midsummer. They continue to darken as they ripen, eventually turning a dark blackish-red. Ripening is progressive, so that mature and immature fruits are to be found on the same tree at the same time.

Until they become nearly black, the fruits are sour but, with the final colour change, they develop their pleasant sweet-and-sour taste. When mature, they are oval or round, and up to 2.5cm (1in) long.

Technically, mulberry fruits are not simple but comprise a cluster of separate fruits. The

The leaves of a black mulberry are usually rounded (top), but they may sometimes be lobed with one, two or four broad rounded sinuses (bottom).



Food for silkworms

The white mulberry has one very important use: as food for silkworms. This tree is by far their favourite food and it has been cultivated in China for this purpose for centuries. The Chinese grow fields of white mulberries, each year progressively stripping off the leaves to feed to the silkworms. The silk is made from the cocoon which the silkworms spin prior to pupating. Several attempts have been made to establish a silkworm industry in Britain, the first being by James I in the 17th century. However, all such attempts have so far failed.

Nut (below): A one-seeded hard fruit that does not split open at maturity.
Horse chestnut
Black mulberry
Samara (below): A one-seeded nut with a parchment-like wing.
Beech
Capsule (above): Seed enclosed in a case comprising several pods or carpels.
Ash
Syncarp (above): A cluster of drupes, each containing one seed.

Above: Mulberry fruits are clustered in an unusual blackberry-like arrangement called a syncarp. But there are several other arrangements of fruit to be found on trees, the most common of which are shown here.

Left: The name black mulberry refers to its ripe fruits. Early in the season these are green. They become paler until more or less white and then darken through orange and red to a reddish-black by the time they mature in the autumn. Notice how the one tree can, at the same time, bear fruits at all stages of ripening.

Below: As its name implies, the white mulberry has much paler fruits than those of the black mulberry. On both species the fruits have the same shape but on the white mulberry they remain white for much of the summer, eventually ripening to yellow, pink or purple, but never becoming as dark as ripe black mulberry fruits.

whole structure is called a syncarp. The individual fruits are fleshy and contain a single nutlet. Because they do not open at maturity they are known as drupes; cherries and plums are other examples of drupes.

Commercial uses From the commercial point of view, the most important part of the black mulberry is its fruits. These make a very tasty dessert and can also be fermented into wine. Mulberry wine is said by some to taste like port; it is sometimes mixed with cider to produce a drink known as mulberry cider.

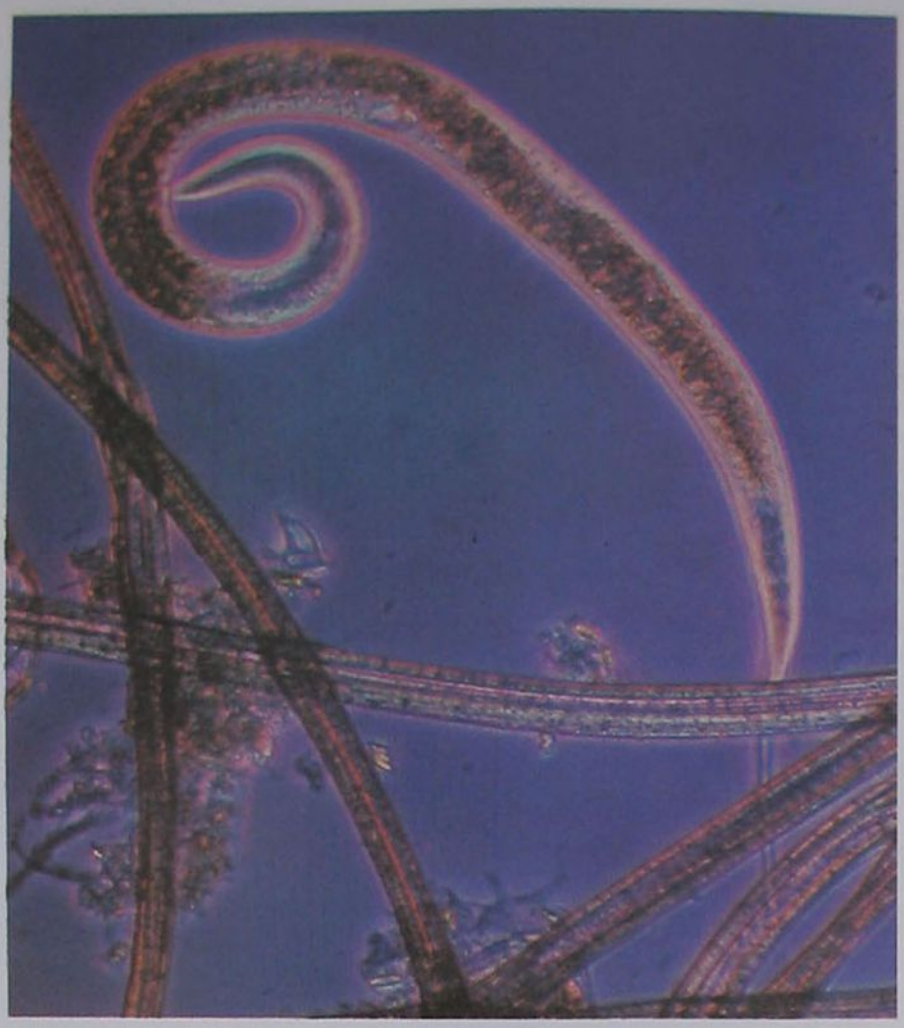
White mulberry This is the species of mulberry famous for being the staple food of silkworms in China. It is native to parts of eastern and south-eastern Asia and has been cultivated in China for silkworms for many hundreds of years. It reached Europe some time in the 12th century–the time of Marco Polo's travels–but did not arrive in Britain until about 400 years later.

The white mulberry is less common in this country than the black species, even though it grows faster and forms a taller tree, sometimes up to 15m (50ft) high. From a distance the two species are quite distinct, the white mulberry being much narrower and with an upright rather than a leaning trunk. Close to, the bark sometimes helps to distinguish them. The white mulberry often has a dull grey or pinkish-brown bark, with age becoming orange-brown, like the bark of the black mulberry. But the best guides to identification are the leaves and fruits.

Leaves, flowers and fruits In shape the leaves of the white mulberry are roughly similar to those found on the black species, but they have a greater tendency to be lobed and may be more rounded than heart-shaped. The texture of the two leaves, however, is quite different. White mulberry leaves have none of the coarse downiness of black mulberry leaves. Instead they are thinner, softer and hairless.

The flowers on each species are much the same but the fruits are distinctly different. Both have the same raspberry-like shape but white mulberry fruits are much paler. Indeed, for much of the summer they are almost white–hence the tree's Latin name, *Morus alba*, which literally means white mulberry.

In the autumn the fruits ripen to yellow, pink or purple, but they never reach the dark colour of ripe black mulberry fruits. Nor do white mulberries ever become as good to eat as the black ones.



NUMEROUS NEMATODES

There are thought to be even more species of nematodes in the world than insects. Some are beneficial to plants and animals, but more important are the parasitic nematodes, especially those afflicting animals–including man himself.

Above: A typical larval stage of a nematode. The tightly coiled part is its head. The dark dots occupying most of its remaining body are globules of fat lying in its intestines. At the end opposite to the head can be seen a long whip-like tail. The larval stages of a nematode are almost always microscopically small as, indeed, the adult may be.

Man has had to live with nematodes–or, to give them their more familiar name, eelworms —for many thousands of years, for they are among his most destructive parasites, whether on himself, his livestock or his crops. Compared with other groups of animals, relatively little is known about nematodes, yet new species are being discovered at such a fast rate that the eventual number of nematodes species is likely to exceed even the number of known insect species in the world.

The range of habitats where nematodes can be found is quite staggering. Soils high up on mountains, the ooze on the ocean floor, the Arctic ice cap, even fibre beer mats–all have their populations of nematodes.

Nematodes are so widespread throughout the world that an American nematologist wrote, 'if all the matter in the Universe except the nematodes were swept away, our world would still be dimly recognisable. We would find its hills, valleys, rivers and oceans represented by a film of nematodes.'

What do they look like? As their common name suggests, nematodes are mostly slender, thread-like creatures, ranging in length from fractions of a millimetre to a metre (3ft) or more, though most are less than 5mm long. Although they are worm-like in appearance, nematodes are not related to earthworms. Their nearest relatives are probably tapeworms, flatworms and flukes.

The anatomy of nematodes is simple. They have a flexible but strong cuticle (skin) which, although often covered in tiny ridges, is not segmented as it is in earthworms. Nematodes lack a rigid backbone. Instead, they maintain their shape by their cuticles, which contain the body fluids under pressure. Together, the cuticle and the fluids act as a hydrostatic skeleton to provide some rigidity.

At one end of the nematode's body lies the mouth. In some cases this is just a simple tube, in others it is elaborately developed for filtering food from passing water currents or for sucking blood or sap. The mouth is connected by a muscular pumping oesophagus (gullet) to a simple tubular gut.

All nematodes have a network of radial and longitudinal muscle fibres, which are controlled by a very simple nervous system, allowing the nematode to produce S-shaped wriggling movements.

Thus a typical nematode looks like a minute transparent sausage, capable of wriggling along in a thin film of moisture. Few nematodes have any natural colouring, but the larger they are the whiter they appear.

Complex life-cycle For such primitive creatures, nematodes have what seems to us to be a surprisingly complicated life-cycle. In some cases both sexes occur on the same individual; others have separate males and females; yet others have no males at all, the female reproducing parthogenetically. Amazingly, some nematodes change from parthenogenic to sexual reproduction, usually at the onset of unfavourable environmental conditions.

Most species lay minute eggs, sometimes containing a well-developed embryo, while others 'give birth' to active young stages. The basic pattern of development is of an egg followed by four or five juvenile or larval stages of steadily increasing size, each stage being separated by moulting until finally the adult stage is reached.

Animal parasites Nematodes can conveniently be divided into those parasitic on animals, those parasitic on plants and those that are free living. Here we describe just the first group.

Not surprisingly, parasitism often evokes a feeling of revulsion, yet to the zoologist it

Right: A caterpillar parasitised by the nematode *Mermithidae*. In country districts this nematode is known as the thunderworm because it tends to appear after thunderstorms. It can grow to several inches long and can be seen waving like a piece of white cotton hanging from the top of a wet blade of grass. Nematodes parasitise so many insects and their larvae that they have been suggested as a means of pest control.

is a fascinating mode of existence, as a brief survey of some nematode life-cycles shows.

Roundworms One of the most familiar parasites is the roundworm (*Ascaris*), which lives in mammals, including man, and birds. It has a relatively simple life-cycle. The adult dwells in the small intestine of its host, absorbing food through its body wall and not usually causing much of a problem. Typically, it lays eggs, which pass out in the faeces and remain on vegetation, which is eventually eaten by another animal. The eggs hatch and the larvae mature inside the gut and so the cycle repeats itself.

Hookworms The story of the hookworm (*Ancylostoma*) is more complex. Also a dweller in the small intestine, the adult hookworm seizes a section of the gut wall in its fearsome mouthparts and sucks blood, often causing considerable distress to the host. The eggs they lay pass outside and fall to the ground. Eventually, they infect a new host, either by being eaten or by hatching into a larva which burrows through the skin, for example, of an unshod human foot. Once inside the body, they circulate in the bloodstream, eventually reaching the lungs where they bore their way out, wriggle up the windpipe and make their way down into the intestines. There the whole life-cycle is begun again.

Alternate hosts Some nematodes species can inhabit more than one species of host. An example is *Trichinella spiralis*. This nematode lives in the gut wall of mammals such as foxes, rats, pigs and even man. The female, which is about 3mm long, gives birth to live larvae, the eggs having hatched inside her without ever having been laid.

The larvae migrate in the bloodstream to various muscles, particularly those controlling the jaws, swallowing and breathing. Here they induce a reaction in the muscles that calcifies them in cysts, a process that can lead to the host dying from suffocation. The dead host, and the cysts, are eaten by another animal, which becomes infected. The cysts break open inside the intestine of the new host, releasing the larvae for the cycle to repeat itself.

Very rarely, man catches *Trichinella* by eating infected pork, the pig having perhaps been infected in its turn by scavenging on a dead rat, and so the cycle goes on.

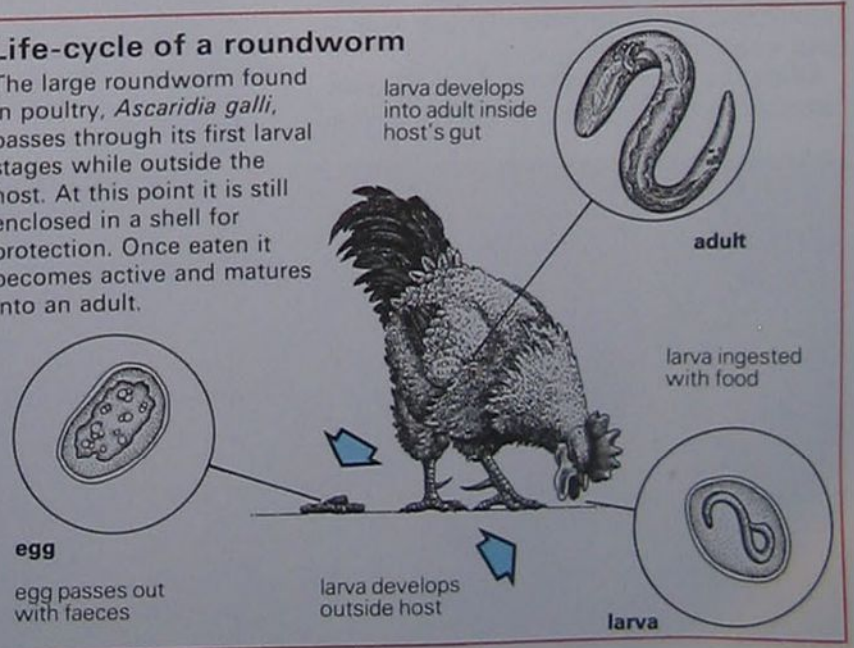
Guinea worms Perhaps the most complicated and sophisticated pattern of parasitism is exhibited by the guinea worm (*Dracunculus*). This nematode is now confined to tropical countries, though it used to be found in temperate areas including Britain until we began to purify our water.

Man becomes infected by drinking untreated water containing small copepods (or water fleas) that are carrying *Dracunculus* larvae in them. Once inside the human body, the larvae leave the now-dead copepod and migrate through the gut wall into tissue, often in the legs. Here they lengthen and mature, producing thousands of eggs that hatch while still inside the parent's body. At this stage, the nematode moves towards the skin, causing a blister to appear and the victim to suffer from a strong sensation of burning. To relieve the pain the victim naturally puts the affected area into water. This causes the blister to burst and the head of the guinea worm to rupture, so allowing the larvae to escape into the water. Here they are swallowed by copepods for the whole cycle to start again.

One of the most widely used symbols of the medical profession is of a pair of serpents entwined around a branch. Its origin lies in an old method of extracting a guinea worm from its victim. The only way to do this is to pull the worm out slowly from within the blister. Since a guinea worm may be more than 1m (3ft) long, this can take several days. In the past, the worm was extracted by winding it around a small stick, which was then fixed close to the wound ready for more winding the following day.

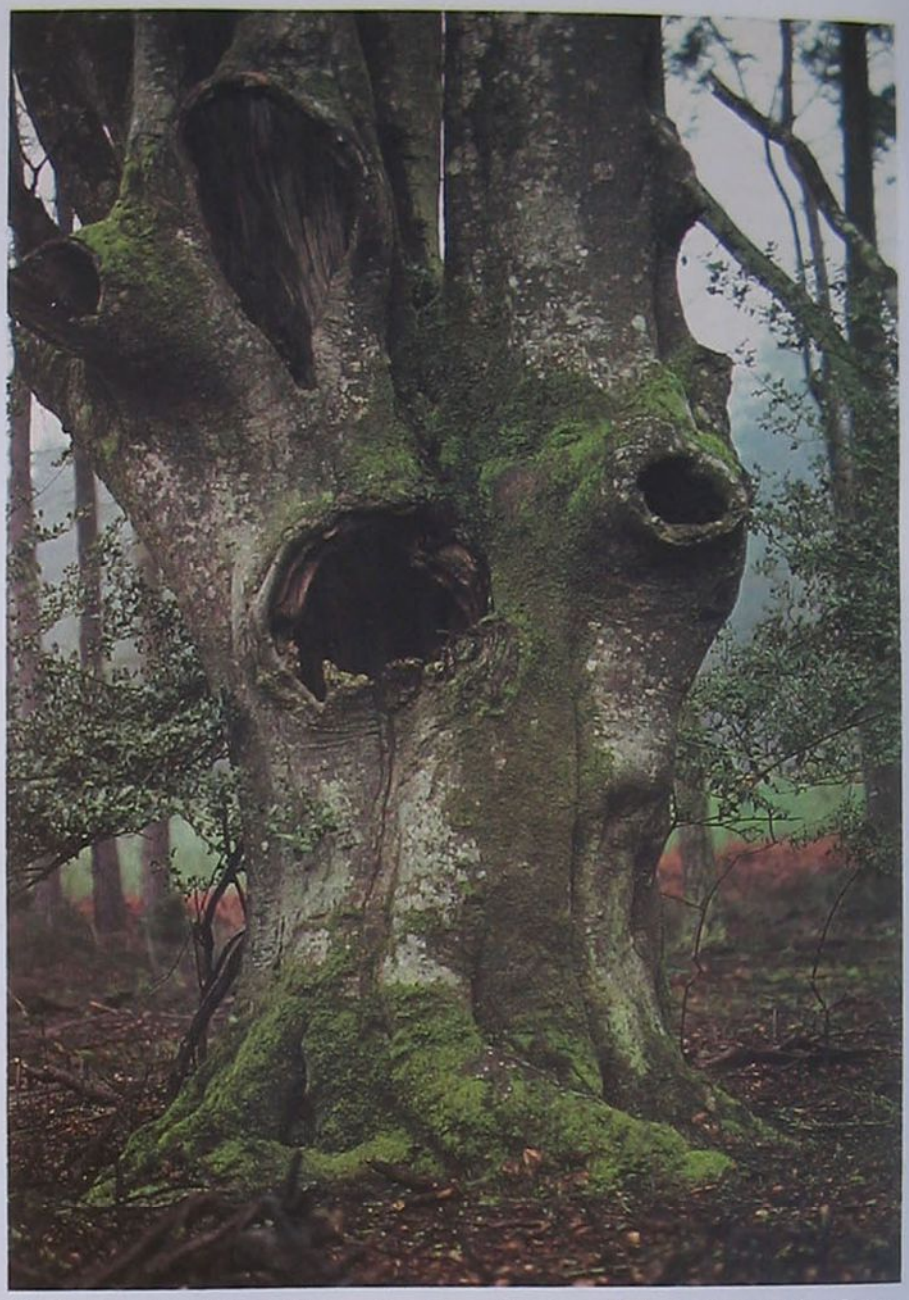
Life-cycle of a roundworm

The large roundworm found in poultry, *Ascaridia galli*, passes through its first larval stages while outside the host. At this point it is still enclosed in a shell for protection. Once eaten it becomes active and matures into an adult.



THE HIDDEN LIFE IN TREE HOLES

Tree holes–formed by the action of fungi, lightning or the excavations of animals–make ideal, securely hidden dwelling places for a host of different animals.



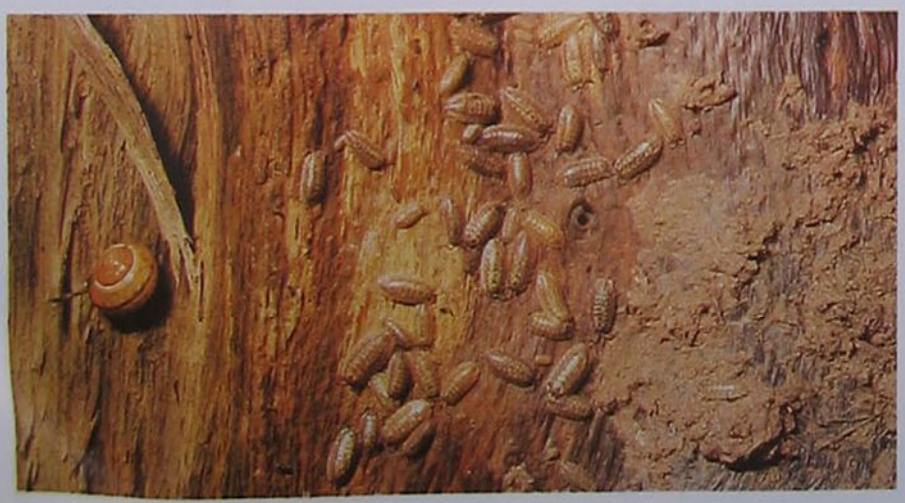
The holes in an old tree like this great beech in the New Forest (above) can harbour a wide range of animals–microscopic protozoans, creatures like woodlice and snails (below), and birds and mammals too.

A walk through woodlands anywhere in Britain will reveal trees disfigured by long gaping fissures, deep callus-ringed holes and shallow depressions–all of them capable of harbouring a highly specialised community of animals that varies according to whether the hole is predominantly wet or dry.

Rot holes and pans When the bark of a tree is damaged, the underlying layer of sap wood, and eventually the inner heartwood, may be attacked by fungi. Various species of beetles can help to spread this fungi as they burrow into the timber. Between them the insects and the fungi cause the damaged area to enlarge and eventually a cavity is formed. This, called a rot hole, is one of the commonest types of tree hole.

The wound that begins the formation of a rot hole may be the result of natural damage by animals, high winds or lightning. It may also be caused by human activities; pollarding, coppicing and the pruning of trees can initiate rotting, as can accidental damage. Some rot holes occur in sheltered positions in trees and remain dry even in heavy rain. Others however, are exposed and rain water fills them, either directly or by running into them down branches. The water may drain away through the rotting wood or it may accumulate, especially when the tree hole is lined with rotted leaves.

Often the openings of rot holes become restricted, even though the cavity is continually enlarging. This is due to the formation of a callus which, in some cases, actually closes the hole. The closure may have an effect on whether or not the hole becomes water-filled, for a restricted opening means that less water will enter–although this may be balanced by a lower rate of evaporation of the tree hole water.



A second variety of tree hole results from the growth pattern of certain trees. They are called pans and differ from rot holes in that they are shallow depressions, lined with unbroken bark, in the tree surface. They may occur when tree crowding leads to the distortion of trunks and branches and, in the case of trees like beech, may be found among the buttress roots. In most cases, pans are shallow and, although nearly always capable of holding water, may lose water rapidly by evaporation.

Both rot holes and pans are extremely common and can be found in a wide range of deciduous trees, including beech, oak, hornbeam and ash. They are less common in

conifers but have been recorded in several species, including silver fir.

Wet holes When tree holes become filled with water they form a specialised aquatic habitat which is colonized by a wide variety of animal life. Numerous protozoans, including the cosmopolitan 'slipper animalcule' *Paramecium*, small crustaceans like *Cyclops*, and rotifers and springtails are found in almost all accumulations of water, and those in tree holes are no exception. Occasionally larvae of the drone-fly *Eristalis tenax* may be encountered; they are found in many stagnant waters breathing air through a telescopic tail which is held up to the surface. The rotting wood and leaves in these holes provide a rich source of food and can support large numbers of individuals.

Although water-filled tree holes cannot be classed as permanent habitats, they can persist for the entire life of a tree which, in the case of beech for example, may exceed one hundred years. Tree holes in the tropics dry out periodically and hence their fauna must either be capable of withstanding periods of dryness during their life-cycle, or else they must be capable of completing their life-cycles very quickly. In this country, however, most tree holes do not dry out completely, even in the summer (they are aided in some cases by water which rises within the tree itself). It has been found that nearly all the fauna can survive as long as the bottom layer of decaying material remains moist.

Above: A willow tit bringing food to its chicks, securely hidden within the nesting hole. This type of hole may well have been made originally by a woodpecker. There are about 20 species of birds in Britain nesting in tree holes, among them the tawny and little owls, the nuthatch, the pied flycatcher and the blue and great tits.

Wet hole inhabitants Perhaps the most interesting and important group of animals are those specifically associated with the tree hole habitat in their immature stages and are seldom, if ever, found elsewhere. By becoming adapted for such a specialised habitat these animals have forsaken the variety of aquatic habitats elsewhere and therefore restricted their choice of breeding sites. But in return, they have escaped their natural enemies, for there are no predatory beetles and dragonfly larvae in tree holes.

In Britain three of our 33 species of mosquito breed exclusively in tree holes. In some areas all three may be found inhabiting the

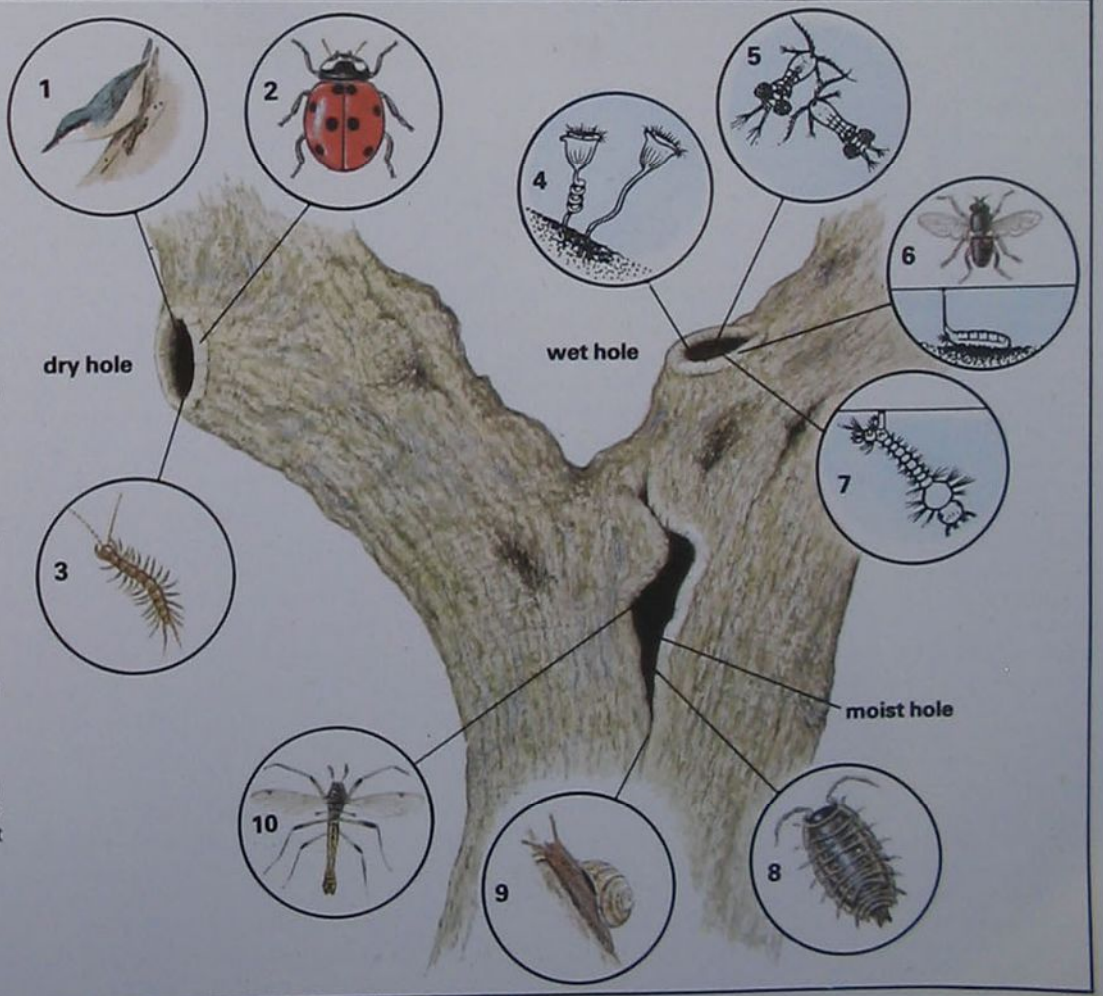
The teeming life in beech tree holes

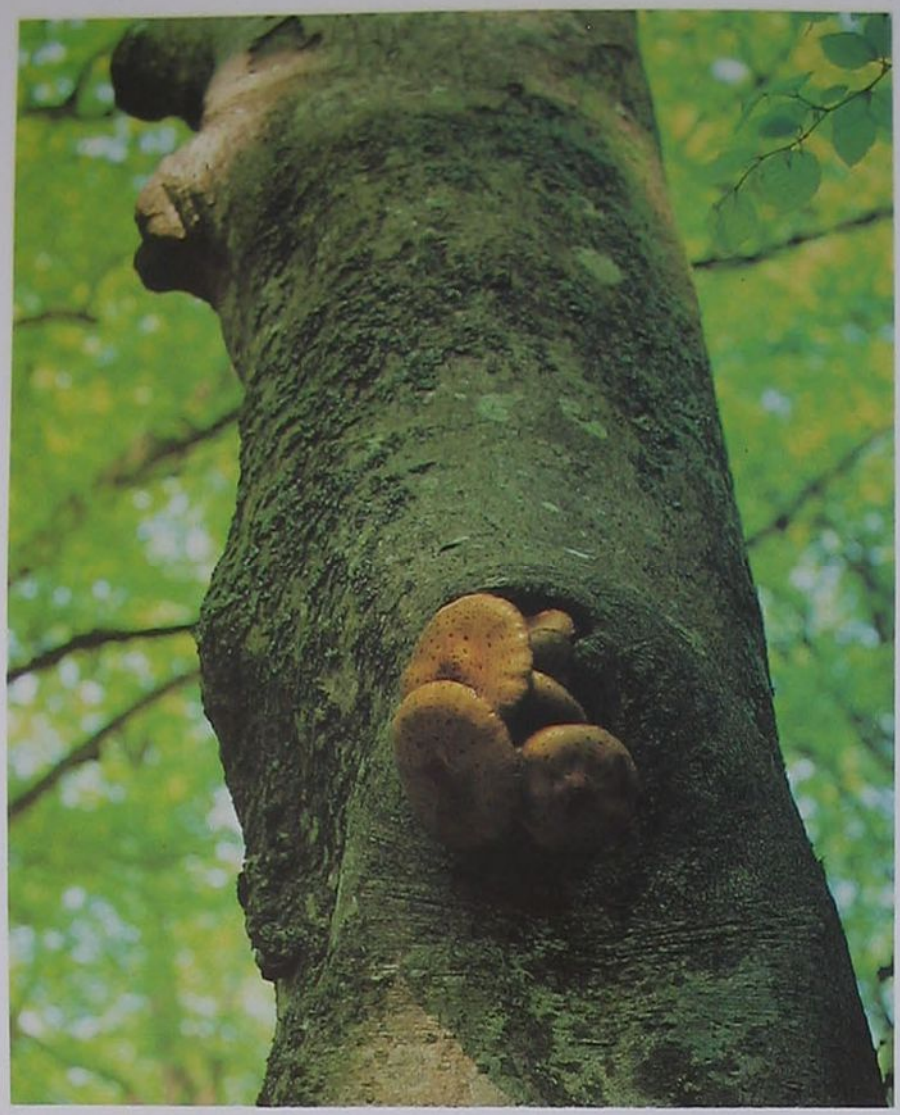
One tree can often have several different types of hole.

Dry holes are usually produced by the removal of a branch (through natural means or by man). The hole develops a callus of scar tissue around it that may eventually close the hole. Since it is vertical it is likely to remain dry in all except driving rain. The dry hole is favoured as a nesting site by the nuthatch (**1**) in spring and summer, but a ladybird (**2**) uses it only for hibernating in winter. Centipedes (**3**) shelter in the dry hole by day.

Wet holes, often found in a horizontal position, receive water directly from the rain and also from stem flow. The wet hole is alive with tiny protozoans, such as vorticella (**4**). Other animals living in wet holes include crustaceans like cyclops (**5**), and the larvae of drone-flies (**6**) and several species of mosquito (**7**).

Moist holes Fissures running the length of the trunk or branch accumulate leaf litter and receive water from stem flow but dry out fairly fast. The dampness suits woodlice (**8**), snails (**9**) and cranefly larvae (**10**).





Above: Fungus growing out of a callus in an old beech tree. Insects like beetles often assist in the spread of fungi as they bore into the tree. There is still much to be learnt about the life-cycles of tree-hole breeding insects and zoologists are using artificial 'tree holes' to find answers. Examination at regular intervals of glass jars and sections of tropical bamboo filled with water and placed at various levels in trees reveals valuable information on the egg-laying periods and duration of the immature stages of the insects. Another study method is to place traps over the openings of tree holes to monitor the emerging adults. Monthly sampling of tree holes and the counting of the number of individuals of each life stage also help to compile a picture of the insects' life histories and give information on the number of generations produced.

same tree hole, but often one species predominates. Little is known about the selection of individual holes by mosquitoes, but observations show that our rarest tree hole breeding species, *Orthopodomyia pulchripalpis*, selects holes containing water rich in tannin and therefore dark in colour. The more common *Aedes geniculatus* and *Anopheles plumbeus* are normally found in clearer water.

Female mosquitoes lay their eggs into the water of the tree holes in the summer months. The eggs may either hatch almost immediately or remain dormant until the following spring. The larvae feed on organic material suspended in the water and on bacteria and algae that they scrape from the walls of the cavity and from the surfaces of submerged leaves. The larvae are active swimmers and are often called 'wrigglers', which describes their way of moving. They are air breathers and so must spend time at the surface, taking in air through an opening at the end of their bodies. Mosquitoes pass through four larval stages and in spring or summer enter a pupal phase, which, unlike that of many insects, is active. Once again, their common name of 'tumblers' describes their movement. Like the larvae they rise to the surface to breathe, but they do not feed. In the summer the pupal skins split and the adult mosquitoes emerge to mate, feed and repeat the life-cycle.

Apart from mosquitoes, a number of fly larvae occur in tree hole water. Among the most numerous are the larvae of the biting midge *Dasyhelea dufouri* and those of the non-biting midge *Metriocnemus martinii*. Both pass through four larval stages, like mosquitoes, and feed on debris in the tree hole.

The immature stages of the hover-fly *Myiatropa florea* are common inhabitants of tree holes, although they are generally found in low numbers. Once again, there is only one generation each year. Unlike the previously mentioned insects, the mature larvae leave the tree hole to pupate in crevices in the bark. The only beetle to breed in tree holes is *Prionocyphon serricornis*, whose larvae may live for up to two years in tree holes.

In addition to the fully aquatic fauna of tree holes, there is also a group of animals which is attracted to moist situations. They include woodlice such as *Oniscus*, snails like *Helix*, and larvae of the cranefly *Ctenophora* and of the moth-fly *Pericoma*.

Dry hole dwellers Dry tree holes offer a valuable and important habitat for a range of terrestrial arthropods, as well as for birds and bats. Some arthropods, such as centipedes and spiders, are found in holes throughout the year, while others, including ladybirds, are present only in the winter, using the protected environment of the tree holes as overwintering sites.

The most obvious inhabitants of our dry tree holes are birds, some 20 species of which nest in tree hollows. Tawny owls, little owls and stockdoves are among those occupying the larger holes, while starlings, blue tits, great tits, nuthatches and pied flycatchers reside in the smaller holes. Often these birds use holes which have been made in a previous season by woodpeckers. When other birds take over woodpecker holes, they may line the floor with nesting material–oak leaves and grass in the case of the pied flycatcher and flakes of bark in the nuthatch–or the nest hole may be used totally unlined as in little owls and stockdoves. Some small birds, including pied flycatchers, reduce the size of the entrance of the nest hole with mud in order to keep out larger intruders.

Like all tree holes, the excavations made by woodpeckers may be enlarged by rotting fungi, become filled with rain and so be transformed into aquatic habitats.

Mammals, too, make their homes in dry tree holes. Squirrels nest in holes in the higher branches, and bats may roost there. Wood mice inhabit holes lower down, while stoats and wildcats make use of holes set low in the boles of trees. In fact, most small wild mammals will make use of dry holes at some time in their lives–as refuge from enemies and shelter from rain and snow. Such rodents as field-mice may well gnaw the insides of the holes to enlarge them or to shape them more to their own liking for nesting.

A TALE OF MAMMAL TAILS

Land mammals use their tails for many different purposes: in courtship, to communicate, for warmth, to assist in flying, as insect swats, and even to deflect attack away from themselves. Aquatic mammals use their tails for steering and propulsion.

Above: Cattle, like this Highland breed, make good use of their tails for flicking away irritating flies and other insects. Many domesticated animals, such as sheep and pigs, have their tails 'docked' for hygienic reasons. Farmers put special elastic bands around lambs' tails so that they eventually drop off.

Mammals have the most versatile tails of any group of vertebrates. A fish's tail is almost always used for swimming, while many reptiles, such as lizards, have tails which, since they carry many of the muscles that move the hind legs, are bound up with locomotion and cannot easily be adapted to fulfil other functions; but when mammals arose, probably some 200 million years ago, the hip, limb and muscle design changed so that the tail could perform a great variety of functions.

A mammal's vertebral column consists of four types of vertebrae: neck (cervical), chest (thoracic), body (lumbar) and tail (caudal). Despite the range of body sizes in mammals, the number of vertebrae in each section is remarkably constant in different species. For example, all mammals have seven neck vertebrae–from the giraffe with its famous long neck, to the whale which has no apparent neck at all.

The number of tail vertebrae is more variable. Some mammals have evolved short tails for convenience, such as the hedgehog which has 14 tail vertebrae, while a rabbit has 16-17. Sometimes one or two tail vertebrae are joined to the pelvic region. They may also fuse as the animal ages. Those at the beginning of the tail have a neural spine where nerves are attached, but those at the tip are just a simple rod of solid bone.

A mammal uses its tail in two basic ways. It may use it physically–to grasp, for example, or to balance itself–or it may use it for communication, usually giving visual signals to its own species or sometimes to its predators.

Extra hands Several of our smallest mammals have tails that can act as extra 'hands', and the harvest mouse is pre-eminent in this field. It weighs only six grammes (less than a quarter of an ounce), so it can climb up stalks to feed on the corn heads without breaking the plant stem. The tip is the most prehensile part of the tail and it is vital in climbing, as well as for steadying the mouse when it is being blown around on the corn heads on windy summer days. When climbing down again, the mouse more often than not curls its tail round the stem and then descends.

You will not find shrews on corn heads as they are insectivorous rather than graminivorous. They do, however, use their tails as an extra hand to a lesser extent when they are climbing. An entomologist who set his traps in trees regularly caught pygmy shrews robbing the traps of the insects inside. Shrews use their tails more as a hook than as a rope, and also for balance as they move about above the ground.

Balance and warmth When it comes to regular branch-to-branch travel there is no doubt that squirrels are the most accomplished tail users, their tails being highly adapted for balancing. The squirrel's tail is half the length of its body and is covered in fine hairs that may be up to 10cm (4in) long. No other British mammal, except the wild pony, has such long tail hairs relative to its size.

Their large bushy tails keep animals such as squirrels and foxes warm as they sleep, and protect edible dormice as they hibernate.

Tales of communication Quite apart from physical functions, mammal tails are important in behaviour, and are highly informative. For example, we know that a dog is happy and friendly when it wags its tail. And when a cat swishes its tail from side to side it is a sure sign of anger.

Rabbits and hares have tails that are white below but dark on top. If a fox appears, the rapid white flashes made by all the rabbits as they raise their tails and run for their burrows are unmistakable warning signals to other rabbits. The brown hare runs from its enemies too, but with its tail flattened so that the white does not attract attention.

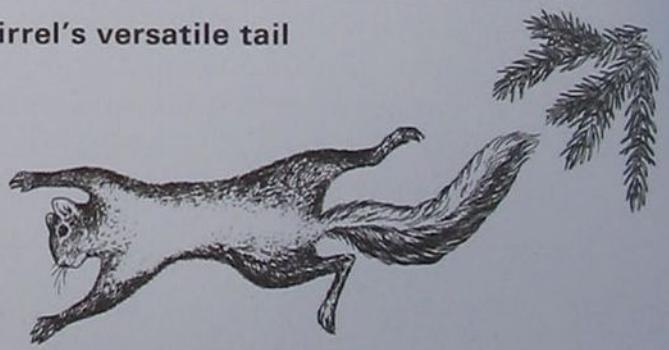
A tale of confusion The common spotted fallow deer has a tail that is black on top and white below. Its rump is white, with dark lines on either side. When a herd is alarmed, all the tails go up to show the maximum area of white, and the deer bound away. The tail area is confusing to predators which do not know which animal to attack. Today, however, the wolves and lynxes that used to roam Britain have gone, so the fallow deer have little need of this protection. Muntjac, sika and roe deer all have different white tail markings for the same reason.

Tails for courtship The fallow deer's tail is also important in courtship. When the bucks compete for does, they hold their tails high to signal their intentions. Dog foxes also raise their bushy tails during courtship, curling

Above: The harvest mouse, our smallest rodent, runs easily up stalks of corn to find food, using its tail for extra support and to slow it as it slides down again. It is the only British species with a truly prehensile tail that can be wrapped several times round a fixed object, so supporting the weight of the animal.

Right: The fox holds his bushy brush out of the way behind him as he hurries along.

The squirrel's versatile tail



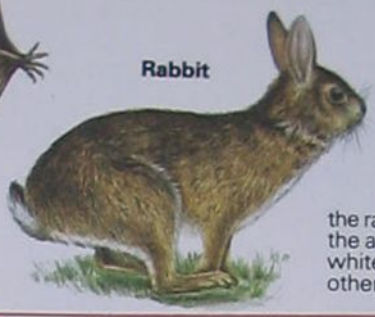
When a squirrel rests on a branch (left) it often flicks its tail to maintain its delicate balance. The tail is also used as a warm fur wrap as the squirrel sleeps in its drey (right). When it leaps from one branch to another (above), the hairs on its tail are fluffed up and help to provide directional stability. If the landing branch moves, or the wind blows the squirrel off course, then it moves its tail, as a pilot turns the rudder of an aeroplane, to get back on course and to avoid danger.

Tails of air, land and sea

During 200 million years of evolution mammal tails have adapted to perform many different functions, and they vary enormously in shape and size.
Shown here are just three of the many and varied uses of tails. They are also used for fly swatting, balancing, to help in gripping, for warmth and for communication. Man also has tail vertebrae, but they are internalised. Other primates have visible tails.

Serotine bat

the bat's tail supports the membrane, which extends between the feet, to help in steering and to form a basket for catching or storing food in flight



Rabbit

the rabbit scut is raised when the animal is alarmed, displaying white underside to warn other rabbits of danger

Blue whale

a whale relies on tail flukes to propel itself through the water

them over their backs flamboyantly as they follow vixens–in contrast to the horizontal position in which they often hold them while on the move.

Territorial tales When it comes to establishing territories, there is no tail more expressive than that of the grey squirrel. Studies have shown that if a squirrel is surprised by another in its territory it will flick its tail gently, a signal enhanced by the white border along its length. If the intruder approaches conspicuously, the resident squirrel raises its tail over its back, and if further provoked it flaps it rapidly, fluffs out the hairs, chatters its teeth and indulges in a bout of mouth smacking. An intruder acknowledging its subordinate position may flatten its tail hairs before slinking off.

Three mammals–the badger, fox and woodmouse–have prominent scent glands on their tails in different positions: at the base of the tail in the badger, half way up on the top in the fox, and on the underside in the woodmouse. Fox scent is dispersed on the air through the hairs, rather like an Airwick. The badger and mouse smear their scents as they move about leaving information about their sex, reproductive condition and social status.

Tails for identification You can distinguish Britain's native red squirrel from some European sub-species by its tail, which bleaches in summer to a light yellow. The wild cat's tail, too, helps in identification: it is thicker and bushier than that of the domestic cat, and has stripes the whole way down to the rather blunt, black tip. Many people find it hard to distinguish a weasel from a stoat, but a look at the tail makes identification easy: a stoat has a black tip to its tail, and a weasel does not.

Aquatic mammal tails The otter's rudder is used for steering and propulsion. The animal flexes it in synchrony with undulating movements of the body and strokes of the paws. Common and grey seals, on the other hand, have almost no visible tails as most of their caudal vertebrae are inside their bodies, so they steer and propel themselves with their hind flippers. Whales, porpoises and dolphins have fish-like tails that are flattened horizontally and moved up and down to propel the huge animals through the water. The vertebral column tapers to the tip and supports two lateral flat flukes that are made of fibrous material.

Below: Fallow deer have tails that are black on top and white below. Their white rumps have dark lines on either side, giving a double horseshoe effect when the tail is at rest.

FIERCE ROBBER-FLIES

The name robber-fly is something of a misnomer–these fierce flies do not steal from their victims, but capture them in mid-flight and kill them.

Above: A robber-fly usually carries prey back to the perch, and then drains it dry. The prey is sometimes cradled in the legs while this happens, although some species fix the prey using just their proboscis while they inject digestive enzymes to liquefy the tissues.

Below: The bee-like appearance of *Laphria flava* is an example of protective mimicry, for it helps to protect the fly from attacks by predators.

Robber-flies are predatory insects belonging to the family Asilidae. There are about 5000 known species–although only about 27 of these occur in Britain–and they include some of the world's largest flies. They feed almost entirely on other insects, which they usually capture in mid-air.

Fearsome faces Most robber-flies are sturdy insects with tapering, cylindrical abdomens. The males have prominent claspers at the hind end, but otherwise the sexes are alike.

The eyes are large, with a patch of extra-large facets at the front. There is a deep groove between the eyes in both sexes, which differentiates them from the males of most flies, which have eyes that meet in the middle. The stout proboscis, used for piercing the prey and sucking its juices, points horizontally or obliquely forwards. The face also bears a dense moustache of hairs and stout bristles, which protects the eyes from the struggling prey.

Territories in the sun Robber-flies are essentially sun-loving insects, found mainly in open country on grassland and heathland. They also frequent the margins of woods. Most species are restricted to areas of well-drained soils because the larvae, being soil-dwelling, cannot survive in waterlogged ground.

Adults are antagonistic towards others of the same species, with the result that each comes to occupy its own territory. Much of their time is spent perched in a sunny spot on the ground or on low-growing vegetation.

Capture-darts The typical method of catching prey is for the robber-fly to dart up from its perch when another insect comes into view. These sorties, known as capture-darts, normally cover only 20-40cm (8-16in). However, not all darts end in capture; the 'prey' may turn out to be a falling leaf, showing that it is movement and not shape that attracts the robber-fly in the first place.

When a victim is caught, it is scooped up by the spiny legs, which the robber-fly holds like a net under its head. The prey is usually caught from behind and is quickly stabbed by the proboscis, normally at the back of the head. It is believed that the robber-fly injects a powerful poison and even large prey is subdued immediately, death following very quickly.

Predator and prey Some robber-flies have distinct food preferences, but all eat a wide range of prey, sometimes including species larger than themselves. Other flies are the main prey of most species, followed by hymenopterans, especially ichneumon flies. Beetles are commonly taken, the robber-fly proboscis being well able to pierce their tough coats.

Robber-flies themselves fall victim to several predators, including birds, dragonflies, spiders and even other robber-flies.

Life history Most robber-flies display little

Above: *Leptogaster cylindrica*. 10mm ($\frac{2}{5}$in) long. Flies May to August.

Below: *Dioctria oelandica*. 15mm ($\frac{2}{5}$in) long. Flies May to July.

Above: *Philonicus albiceps*. Up to 22mm ($\frac{4}{5}$in) long. Flies June to October.

finesse in their mating habits, although a few of the more delicate species such as *Leptogaster* and *Dioctria* do have some form of courtship. They fly to and fro in search of females, which they find by sight or smell, and then flutter in front of them, trailing their long legs as they dance up and down.

British robber-flies usually have soil-dwelling larvae, although the eggs are not necessarily laid in soil. The female normally lays eggs in small batches, distributed over a large area. Some species lay their eggs in the flowers of grasses and other plants, or on the leaves of low branches of trees and shrubs, the larvae falling to the ground as soon as they hatch.

The larvae are cylindrical or slightly flattened with a small, but well-marked, head and a number of wart-like outgrowths along the body. Although some may nibble animal matter if they come across it, they are mainly vegetarians, feeding on decaying plant material. They pupate in the soil, or in wood. The pupae have strong spines and they use these to wriggle back to the surface when the adults are ready to emerge.

Common robber-flies Several species are commonly seen in different parts of the British Isles. *Leptogaster cylindrica* is a slender, brownish insect with long legs. It can easily be mistaken for a cranefly, especially when in flight. It is on the wing from May to August in grassy places, often along the edge of woods, as far north as Yorkshire.

Above: *Asilus crabroniformis* is one of our largest flies, at 2.5cm (1in) long.

Below: Robber-flies like *Machimus atricapillus* find a mate in much the same way as they find food—with a quick dash and a grab.

Instead of making capture-darts like most robber flies, this insect flies daintily over vegetation, trailing its long hind legs almost vertically and holding the front ones out to pluck aphids and other small insects from the leaves.

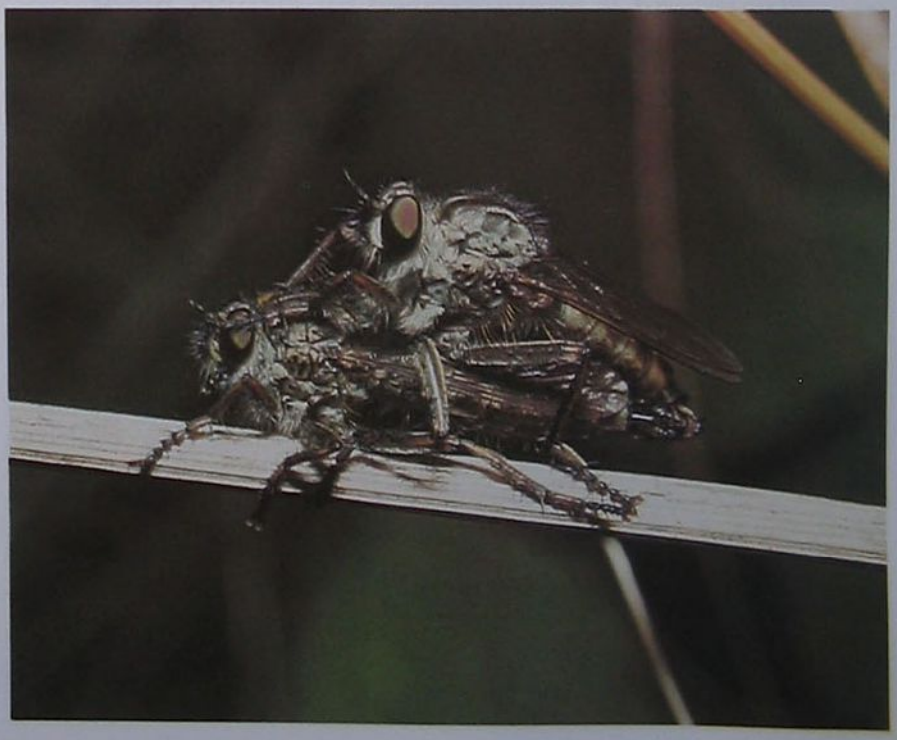
There are six species of *Dioctria*, the largest British genus. All are rather slender, dark-coloured flies with a distinct resemblance to ichneumon flies, their preferred prey. *D. oelandica* is a striking species with orange or yellow legs and dark wings with a deep violet sheen. One of the few robber-flies that prefers woodlands, it is found from May to July in old woodland from Perth southwards.

Machimus atricapillus is one of our commonest species. It measures up to 15mm ($\frac{3}{5}$in) long and is drab grey with red and black legs. It inhabits woodland margins, hedgerows and roadsides from June to September, where its main quarry is medium-sized flies, although bees, small butterflies and grass moths are also taken.

The fearsome, hornet-like *Asilus crabroniformis* is seen from July to October on heathland and downland, from Merseyside southwards. It is harmless to humans, despite its frightening appearance, and preys on flies, bees, wasps, beetles and grasshoppers.

Philonicus albiceps has a coat of yellow-grey hair which camouflages it in its natural sand-dune habitat. Common in most coastal areas from June to October, it preys mainly on other flies.

Laphria flava, on the wing from June to September in Scottish pine forests, is a stout, hairy species about 2cm ($\frac{3}{4}$in) long. One of the many bee-like robber-flies, it is said that its appearance helps *Laphria* to capture bees, although it also takes many other insects. In fact, its bee-like appearance probably serves more as a protection against predators.



FLOWERS OF MOORS AND HEATHS

Heathland is characterised by distinct plant communities that are more or less confined to this region. Although dwarf shrubs such as heather predominate, a careful search reveals many small, colourful species on both moors and heaths.

Above: Gorse and heather spread a blaze of colour across both wet and dry heaths in late summer. The pale pink ling (*Calluna vulgaris*), seen growing here with gorse (*Ulex europaeus*) and the deep pink Dorset heath (*Erica ciliaris*), is one of the most abundant heathland shrubs.

Heathland develops on poor, acid ground. Vast expanses of our 'granite' uplands in Scotland and northern England are covered with heather moorland, while in southern England lowland heaths are a characteristic feature of acidic, sandy soils. The result of forest clearance in these areas, heathland would never have developed on such a scale were it not for man's intervention–in both ancient and recent times. As heathland is not strictly a natural habitat, left to itself it would soon be recolonized by trees such as the birch, an important pioneer species.

However, man rarely leaves heathland totally undisturbed, and periodic burning and grazing ensure that no invasion by trees takes place. Upland heather moors are often burnt over to encourage growth of new shoots on the heather–a staple food of the grouse. Elsewhere, heathland is grazed by sheep, cattle and–in southern England especially–wild ponies.

Types of heathland Dry heaths obviously occur on well-drained soils, whereas wet heaths develop on soils that tend to be waterlogged. The most obvious and characteristic plants of both types of heathland are the heathers–in particular ling and purple bell-heather and, on wetter ground, cross-leaved heath. The other plants found on heathland can be divided into those species that grow on wet or dry heaths, although the boundaries are never very clearly defined.

Shrubs of dry heaths Bilberry is a low-growing deciduous shrub which is very common on the northern heather moors, but much less so in the south. The green, woody twigs bear small, oval, bright green leaves. Although these are shed in autumn, the green twigs can continue to photosynthesise–and therefore manufacture food–whenever light and temperature conditions are favourable during winter and early spring.

The flowers, which appear in April, are globular, dull pink structures which droop from short stalks rather like miniature lanterns. They have no scent, but secrete nectar around the base of the style. This attracts bees which are the most important pollinators as

Cross-leaved heath (*Erica tetralix*). Flowers July-August, wet heaths. Ht to 40cm (16in).

Purple moor grass (*Molinia caerulea*). Flowers July-September, wet heaths. Ht to 1.2m (47in).

Heath milkwort (*Polygala serpyllifolia*). Flowers May-August, dry heaths. Ht to 10cm (4in).

Bristle-leaved bent grass (*Agrostis setacea*). Flowers June-July, sandy heaths. Ht to 50cm (20in).

Bog myrtle (*Myrica gale*). Flowers April-May, wet heaths. Ht to 1.5m (59in).

they have a proboscis long enough to reach the nectar source. As the bee hangs on to the flower and inserts its proboscis to take the nectar, pollen is shaken out on to its head, to be carried to the next flower visited by the bee.

Dwarf gorse (*Ulex minor*) is abundant on some heaths, where it grows in scattered clumps or forms low-growing prickly thickets. Instead of leaves, it has stiff, greyish-green spines which help to deter grazing animals. It is similar to the common gorse in most respects, but generally smaller overall with shorter, weaker spines and smaller, pale yellow flowers.

Bees visiting gorse flowers trigger an 'explosive' mechanism which dusts their undersides liberally with pollen. Small, hairy seed pods succeed the flowers and these dry out as they ripen, until they spring open violently, scattering their seeds in all directions.

Flowers of the turf The spaces between clumps of heather are often covered by patches of bristle-leaved bent grass, a species with stiff, narrow leaves that form compact tufts. These open patches of turf allow a number of species to thrive, which would not otherwise survive under a dense stand of heather.

The slender stems of tormentil grow from a stout, woody rootstock. The leaves are usually divided into three sharply toothed leaflets and the bright yellow flowers, which appear in May, are supported on thread-like stalks. Tormentil was valued by practitioners of folk medicine–the leaves were steeped in brandy and the resulting concoction was used to treat stomach ailments.

Heath milkwort is a tiny, moorland plant that is easily overlooked. The bases of the stems are crowded with opposite pairs of tiny, oval leaves, but higher up the stem they tend to be alternately spaced. A loose spike of three to eight flowers, varying in colour from dark blue to purplish pink, appears at the tip of each slender stem.

Wet heaths The floral composition of wet heaths is rather different from the drier areas, although heathers are again usually dominant. Purple moor grass is often abundant, and sometimes the prevailing species, in wet heath areas. A robust grass with greyish, slightly hairy leaves, it forms sizeable tussocks and owes its name to the purplish flower spikes and leaf sheaths.

Aromatic shrub Bog myrtle is often found growing among tussocks of purple moor grass. It is a deciduous shrub with smooth,

Below: Heath bedstraw (*Galium saxatile*) is often found alongside the yellow tormentil (*Potentilla erecta*) where it forms little creeping mats or clumps. The square stems are ringed by whorls of spear-shaped leaves that are rather rough to the touch because of tiny, forward-pointing prickles. The clusters of delicate white flowers appear from June to August, and emit a rather sickly smell which attracts flies to pollinate them.

red-brown twigs and oval, greyish green leaves which are slightly downy on the undersurface.

The flowers take the form of reddish catkins which are wind-pollinated in April before the foliage has appeared. Male and female flowers are borne on separate plants, but a curious feature is that a bush which is male one year can be female the next, and vice versa.

The twigs and leaves are covered with resinous glands and, if rubbed, release a very pleasant scent. The aromatic foliage was once used in the home as a moth repellent.

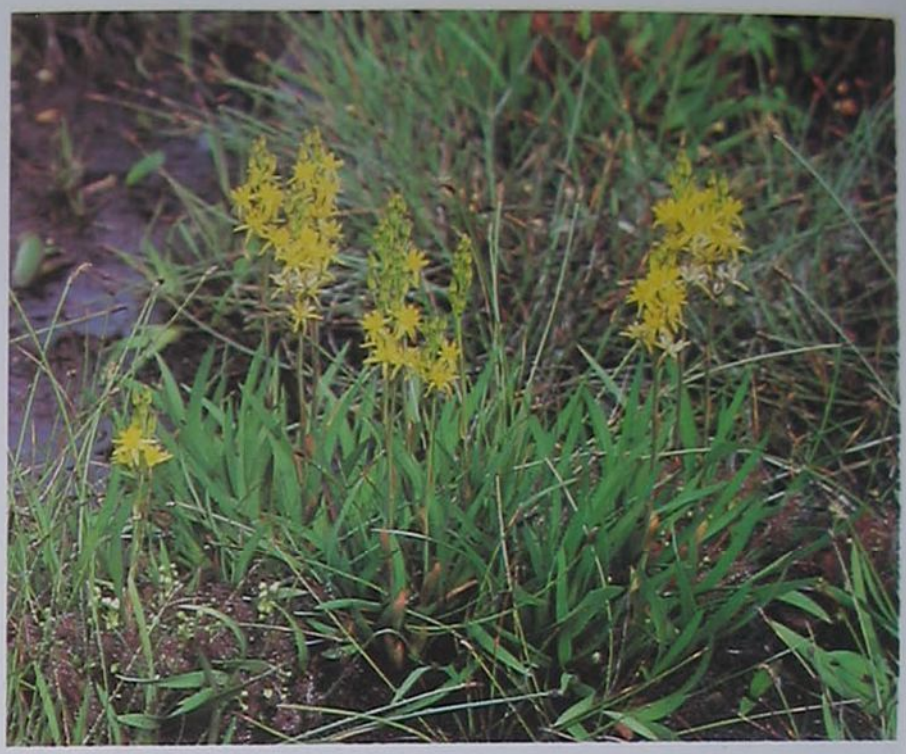
The berries – which are small and flat with two wings – are rich in resinous wax. This was extracted in boiling water in the preparation of myrtle wax, widely used as a furniture polish and for making scented candles. In Yorkshire, bog myrtle had yet another use; it was used instead of hops to provide the bitterness in 'gale' beer, a refreshing home-brew.

Water-loving flowers The heath-spotted orchid is one of the most attractive flowers of damp heathland. Its fleshy, bright green leaves are sometimes, but not always, speckled with black, circular dots. It may take several years before it produces its first flower spike. The petals vary greatly in colour, ranging from white through light pink to pale purple, and they are spotted with crimson.

As in most orchids, the pollen-bearing anthers are modified so that instead of releasing loose, powdery pollen, the grains are bound together by a pair of elastic threads into two pollen sacs or pollinia. A droplet of tacky liquid, setting in a few seconds, glues the tips of the pollinia to any visiting insect. The pollinia are positioned very accurately so that they are caught on the sticky stigmas of the next flower to be visited.

The pinkish purple flowers of the lousewort are borne in a leafy spike, and the small leaves have a distinctly fern-like appearance. The flowers are pollinated by bees which land on the lower lip of the flower, causing the upper hood, which is folded around the stamens, to open. This releases a shower of pollen on to the bee's back, while at the same time stigmas pick up pollen already clinging to the bee after a visit to a previous flower.

The bog asphodel, another species of wet heathland, is a member of the lily family. It has a basal cluster of narrow, sword-shaped leaves through which it sends up its long, slender flowering spike. The bright yellow star-shaped flowers remain open during rain, which may be responsible for pollinating them. The flowers fill with raindrops to a level which allows the pollen grains from the prominent orange anthers to float on the water's surface, where some inevitably come into contact with the female stigmas. When the flowers have died away in August, the dark orange seed capsules appear.



Above: Bog asphodel (*Narthecium ossifragum*) grows on the wettest part of heaths and flowers from June to August.

Left: Insects visiting the flowers of the heath-spotted orchid (*Dactylorchis maculata*), which appear from May to July, do not find any nectar despite the fact that the petals are fused to form a characteristic nectar-containing spur. Fortunately for the future of this orchid, which relies on insect pollination, the insects have yet to learn that it is an unrewarding plant to visit.

Below: Lousewort (*Pedicularis sylvatica*) is found on bogs, moors, and damp heaths, where it is in flower from May to July.

SKILFUL DIVERS OF REMOTE LOCHS

A rare and thrilling sight on remote lochs and islands, divers – hardy, Arctic birds – are experts at diving and underwater swimming. At breeding time their wild, shrieking calls, uttered on water and in flight, ring out by day and night.

Below: A black-throated diver walks ashore to its nest. Divers sometimes build a substantial heap of waterweed and grass, but the simple type shown here – a grass-lined hollow – is more usual for all species.

All four of the world's species of divers are to be seen in Britain and Ireland, although one, the white-billed diver (which breeds in Arctic North America), occurs very infrequently, usually only one or two individuals being seen during a year. The two smaller species, the red-throated and black-throated divers, breed in the north and west, but travel south to spend the winter at sea around all our coasts, so that they can be found somewhere in Britain and Ireland at any time of the year.

The great northern The huge and spectacular great northern diver was made famous for many in Arthur Ransome's book for children, *Great Northern*. In most years, some adults spend the summer on remote lochs in northern Scotland, and once every few years a pair attempts to breed. Only once in recent decades, in 1970, has breeding proved successful and resulted in a couple of youngsters.

Most great northern divers breed in northern North America, Greenland and Iceland. On the other side of the Atlantic they are called 'loons', a name which is often thought to derive from their song. Of all bird calls, that of the great northern diver must count as one of the most thrilling. Its weird cry, like a whooping, lunatic laugh, echoes wildly across the lochs between the mountains and forests of their breeding grounds.

Breeding areas of Britain's divers

The great northern and white-billed divers are too rare to be shown on our map. Black-throated divers are slightly more numerous, with 150 breeding pairs in Scotland; while only the red-throated divers are outside the class of rare birds, for there are about 1000 pairs of these in Scotland and Ireland. They are also the only ones that breed in Orkney and Shetland, for the lochans (small lochs) there are too small for the other divers, which need plenty of room for taking off and landing.

black-throated diver

red-throated diver

In full summer plumage, the bird is as spectacular as its song. Great northern divers are goose-sized, but with a short, thick neck and a powerful, dagger-like beak. The head is black with a greenish metallic sheen, and the back is black, but chequered with many brilliant white squares. On the side of the neck is a small black and white striped patch. In winter the plumage is much drabber: dark grey-brown above, shading to greyish white below.

Black-throated diver In summer, this bird could be mistaken for the great northern, as its plumage colours are an equally crisp combination of black and white. However, the black-throated diver is considerably smaller and slimmer, and has a less powerful looking neck and beak. The underparts are white and the back is black, with a chequerboard pattern of white blocks similar to that of its larger relative, but the head and nape of the neck are a plain dove-grey, while the throat, as the name suggests, carries a large, pure black 'bib'.

In winter, although the basic colours are similar, the dividing lines between dark upper parts and pale underparts are far more precisely defined than the smudged margins of the great northern, and head and beak sizes remain a good identification feature.

Red-throated diver This is the smallest of the family, though only slightly smaller than the black-throated. In summer it is easily recognisable because the upperparts are clearly brown, not black, and quite uniform rather than spotted. The head and neck are a finely streaked grey, and the 'bib' is a rich deep chestnut red, though at long range this may look black. An excellent identification feature at all times is the beak, which is slender and always seems to be tilted upwards.

The calls of the black-throated (above) and red-throated diver (below) are similar—gruff, barking noises, and wailing calls interspersed with cackling or yodelling phrases—but less exciting to hear than the great northern diver.

In winter, the beak remains the best distinguishing feature separating red-throated from black-throated divers, but in addition the red-throated diver's back is brownish-grey and densely speckled with small white spots—a useful guide at close range.

Divers in flight The divers have a very characteristic flight silhouette, which helps (particularly in winter) to separate them from cormorants, shags, ducks, geese and grebes. The body is pencil slim, the wings slender and set well back, and the flight is straight and fast with powerful wingbeats. In the case of the black-throated, the wingbeats are conspicuously (and surprisingly) shallow. There are no interruptions for spells of gliding, as in the gannet or cormorant, for example. The tail and feet often seem to be held slightly depressed, and in the two smaller species the head and neck also droop a little, giving a hump-backed appearance.

The quiet of the loch All divers choose remote lochs for their British breeding grounds, the great northern and black-throated divers needing relatively large areas of water. The red-throated seems happy on the smallest of moorland pools, which explains why it is so widespread in the Orkney and Shetland Islands, where the lochans (small lochs) are tiny, and why the black-throated diver is absent there. Also, red-throated divers often fish far from their home pool, flying off to a larger loch or out to a sea-

Divers in summer plumage
Great northern diver
chequered back and forewing
thick powerful neck
striped neck patches
Great northern diver (Gavia immer); mainly winter visitor, rarely breeding. Length 69-90cm (27-36in).
White-billed diver (Gavia adamsii); largest diver; vagrant. 76-90cm (30-36in).
Red-throated diver (Gavia stellata); smallest diver; resident (breeds April-Sept). Length 53-69cm (21-27in).
Black-throated diver (Gavia arctica); resident (breeds April-Sept). Length 58-73cm (23-29in).
Black-throated diver
head and nape grey
striped neck with black throat
red throat
Red-throated diver
bill frequently held upright
bill yellow in summer
White-billed diver

loch perhaps some miles away, and so can be content with a small pool for nesting.

Winter on sea or reservoir Divers can be seen in coastal waters during their spring and autumn migrations. Many, probably including Scandinavian birds, spend all winter around our coasts, often well out at sea but coming closer inshore in bad weather. Many large reservoirs, often well inland, have also become regular places for seeing divers in winter.

These reservoir birds offer by far the best chance to watch the fishing technique (and time the diving durations) of the various species. The hunting diver patrols the surface, often putting its head underwater to scan for fish or other prey, including molluscs and crustaceans, and even large insect larvae and worms. If a likely food item is sighted, the diver slips beneath the water surface, sinking easily from view and hardly causing even a ripple.

Once under the water, they are mobile and speedy. The great northern and red-throated divers regularly reach a depth of 10m (30ft), and there are records of divers caught in fishing nets 70m (230ft) under water–surely a world record for diving birds.

Ancient species The earliest diver-like fossils date from 100 million years ago, placing the divers among the first recognisable fossil bird groups. The continued presence of such a seemingly 'primitive' line must surely testify to the success of divers as underwater fishers. The body is well streamlined for underwater movement, being torpedo-shaped, and the wings are relatively small in proportion to the body, offering little resistance in the water. The feet, set back near the tail, are highly efficient in propelling the bird under water, though rather ungainly on land.

Above: A great northern diver incubating eggs on its nest, a task that takes about 33-35 days. Fledging is slow in this large species, taking 10-11 weeks. Both processes are quicker in the smaller species.

MOSSY-CUPPED OAK TREES

At a glance, the Turkey oak and its close relative, the hybrid Lucombe oak, may seem much the same as our own native oaks. But take a closer look and the difference soon becomes apparent in their strange mossy-cupped acorns that take two years to mature.

Above: The long ascending branches stemming from a fairly short stout trunk to form a broad domed crown give the Turkey oak its typical shape.
In Britain, the Turkey oak is a fast-growing vigorous tree, able to flourish on a wide range of soil types, and has become a popular ornamental species for parks and gardens. It grows especially well in southern England, where it has become naturalised in woods and hedgerows.

Britain has only two native species of oak, the English or pedunculate oak and the sessile oak, but on the mainland of Europe there are many more oak species. All can be found growing in parks and public gardens in this country, but only a small number have become naturalised here. One of the few to do so is the Turkey oak.

This tree is native to south-east Europe and Turkey, to which, presumably, it owes its name. It was introduced to Britain around 1735 and soon proved to be extremely hardy and fast-growing here. However, hopes that it would prove to be a valuable source of timber were dashed when it was discovered that the timber from Turkey oaks grown in Britain was brittle and not at all durable.

Nevertheless, it soon became popular as an ornamental tree in parks and gardens throughout much of the British Isles. It grows especially well in southern England where, with the help of birds and mammals collecting its acorns, it has spread to the wild and become established in hedgerows and woods.

One of the reasons for the Turkey oak's success in this country is its tolerance of different soils. It grows equally well on light sandy soils and heavy clays, provided they are well drained. But it does not thrive in exposed windy places, for the brittleness of its timber makes its branches liable to snap off suddenly during a strong gale.

Fast grower The Turkey oak is a handsome upright tree with a spacious domed crown. It grows faster than any other species of oak to be found in Britain and the tallest are around 40m (130ft) high. This is almost as high as our tallest native oaks, yet our Turkey oaks are all less than 250 years old, which is comparatively young.

The bark of a Turkey oak is much darker than that of our native oaks. In old age it becomes rugged and cracked by deep fissures. The slender twigs have a coarse, knobbly appearance due to numerous small brown buds that are arranged alternately in a spiral around the length of the shoot. The buds are enclosed in a fine down and almost hidden by

Right: The Lucombe oak generally forms a broader, squatter tree than does the Turkey oak. In all but the harshest winters it retains its leaves until spring.

Left: The Turkey oak differs from our native oaks in both leaves and fruits. Its leaves are generally more slender with pointed lobes and its acorns are borne in mossy cups. At the leaf-bases are long stipules. Our native oaks have smooth-cupped acorns and lack stipules.

Lucombe oak
(Quercus lucombeana)

Turkey oak
(Quercus cerris)

dark whisker-like strands. These are the shrivelled remains of stipules that were hanging from the base of the leaves earlier in the year. Among oaks, only the much rarer chestnut-leaved oak shares this strange feature.

The foliage unfurls early in May. At first, the pale green lower surface of the young leaves is covered in a grey woolly down, but this is shed by the time the leaves have expanded fully. The lower surface remains pale green but the upper surface is a much darker green and quite glossy.

The shape of the leaves varies greatly but they have the familiar lobed outline of our native oaks. However, the lobes tend to be narrower and more pointed. The Turkey oak retains its leaves long into the autumn and, on a young tree, they may even persist in a withered condition throughout the winter.

Catkin flowers The flowers of the Turkey oak are similar in structure to those of the common oak. The male flowers consist of catkins about 5cm (2in) long, hanging in dense bunches. In May they ripen and become tinged with red before opening to release clouds of pollen. The female flowers are inconspicuous round structures about 5mm ($\frac{1}{4}$in) across. They appear at the base of the leaves on new shoots.

Following fertilisation the female flowers develop into small acorns that are characterised by their curious mossy-looking cups (properly known as cupules). Indeed, in some parts of the country it is more commonly known as the mossy-cupped oak. These distinctive acorns remain on the tree, slowly ripening, for two years.

Lucombe oak In 1762 an Exeter nurseryman named William Lucombe noticed that two species of oak he had planted close together cross-pollinated to produce a hybrid oak. The two species were the Turkey oak and the cork oak, a Mediterranean species whose bark is harvested as a source of cork. The hybrid was named the Lucombe oak in his honour.

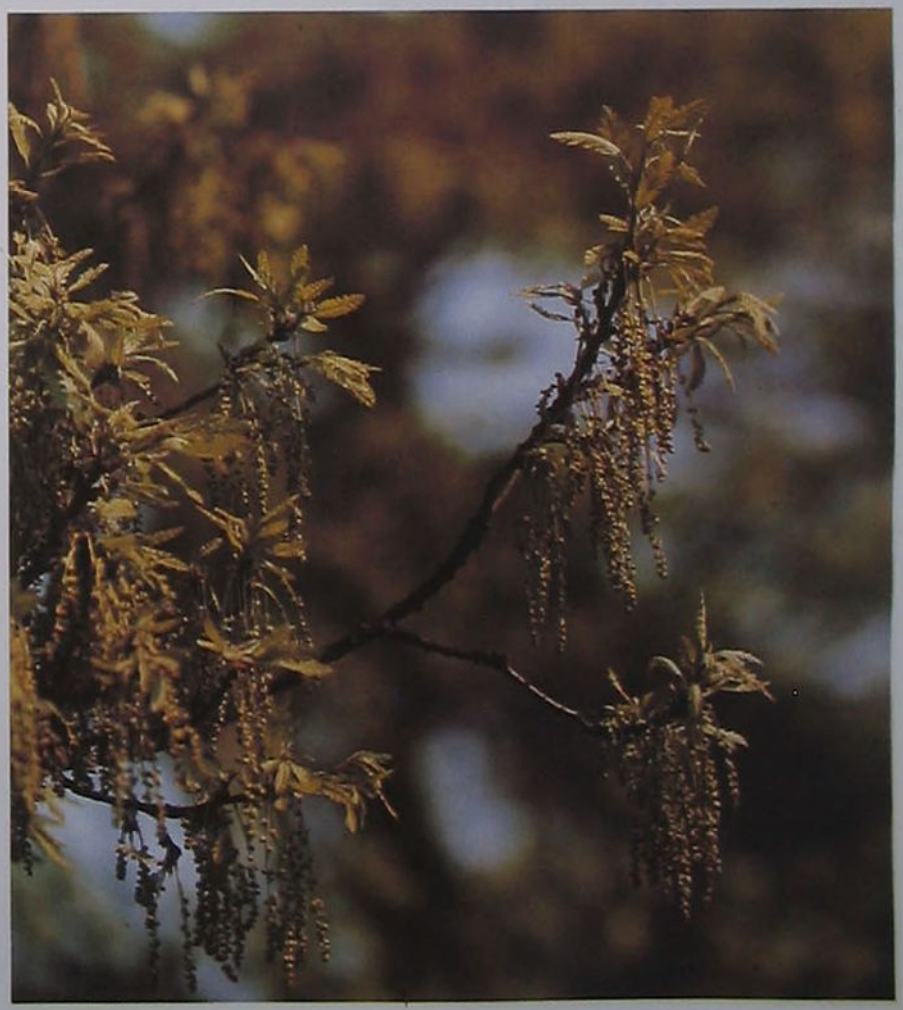
The Lucombe oak turned out to be very hardy and exceptionally vigorous, forming a superb ornamental tree for parks and gardens. The tallest on record in Britain is a 38m (125ft) tall tree growing at West Dean in Sussex.

The trunk of a Lucombe oak is shorter than that of a Turkey oak, and its widely spreading boughs form a broad ample crown. The bark is thick and rugged, in mature trees becoming deeply furrowed. The leaves, flowers and fruits are all similar to those of the Turkey oak–in particular the Lucombe oak has the same mossy-cupped acorns–though the leaves are a much darker green on the upper surface. One major difference, however, between the two trees is that the Lucombe oak is almost an evergreen tree, as indeed is the cork oak.

Turkey oak (*Quercus cerris*). Deciduous tree, native to south-east Europe and Turkey. Height to about 40m (130ft).

Lucombe oak (*Quercus lucombeana*). Semi-evergreen hybrid between the Turkey oak and the cork oak. Height to about 30m (100ft).

Below: A Turkey oak about to flower. The catkins are male; the female flowers are small and borne at the bases of the leaves.



TENTACLED PREDATORS

Among the most elaborate molluscs in our sea are the squid – highly advanced predators who reach out and grab their prey with long, sucker-covered tentacles.

Above: One of the strangest squid to be found in the waters around Britain is a deep-sea species called *Histioteuthis*. This squid has one eye (the one shown here) much larger than the other, though no one is yet sure why. The dark dots scattered about its body are light organs, thought to be important for camouflage.

The squid you see on a fishmonger's slab or preserved in a museum jar convey a poor impression of these highly specialised predators. Possessing only a delicate pen made of chitin to support their body, in death they collapse into a shapeless mass that reveals little of their appearance in life. The result is that squid are, to most people, among the most obscure marine animals, a circumstance that has probably contributed to their traditional science-fiction role as alien monsters.

Squid structure Squid are classed as molluscs, their closest relatives being cuttlefish and octopus. The outer part of a squid's body, called the mantle, consists of a cylinder of muscle that tapers to a point at one end and joins on to the head at the other. A chitinous internal shell, called a pen, extends along the inside of the body attached to the upper surface. Suspended from it are the internal organs for breathing, digestion and reproduction.

Apart from the organs, the rest of the body is simply a cavity used by the squid for locomotion. When the walls of the cavity contract, water is forced out through a funnel close to the head, thus jet-propelling the squid along. The cavity is then opened to allow water in for the next thrust. Normal motion is tail-first but, by controlling the funnel, the squid can move in any direction and can perform rapid turns.

Attached to the head of a squid are eight arms and two tentacles. The ends of the tentacles thicken into clubs which are studded with suckers. To catch prey, such as fishes, the tentacles are extended and the prey grasped between the clubs. The tentacles then withdraw and pass the prey to the arms, which are also covered with suckers. These hold the prey while the squid tears off chunks of food with its sharp beak.

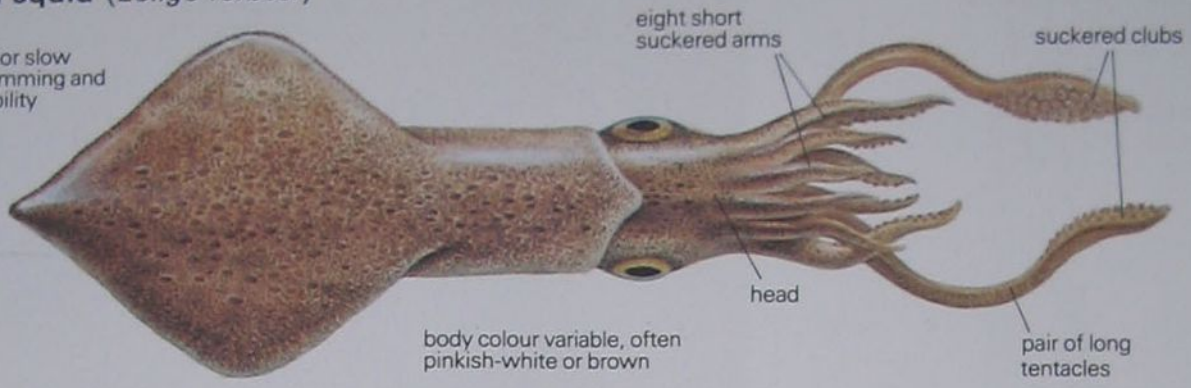
Below: The arms of a squid are equipped with powerful suckers for holding on to its prey while feeding.

Colour changes An important aspect of the squid's behaviour is its ability to change colour very rapidly to confuse both prey and predators.

The remarkable feature of the squid's colour change is that it appears to happen instantaneously. Most animals that can change colour do so slowly. The reason for this is that the message to change colour is passed from the brain to special glands that secrete hormones. The hormones act as chemical messengers and travel in the bloodstream to the skin where they trigger the pigment change.

In squid, the situation is quite different: they do not need hormones to trigger the change. Instead, the brain sends a message via a nerve directly to special cells in the skin containing the pigment and a special set of muscles. When the muscles relax, the pigmented area expands and the colour shows. When they contract, the cell pigment disappears from view. Since messages can travel along nerves far faster than hormones can

Common squid (*Loligo forbesi*)


fin for slow swimming and stability
eight short suckered arms
suckered clubs
head
body colour variable, often pinkish-white or brown
pair of long tentacles

travel in the bloodstream, the squid's technique is obviously much quicker.

To see how the squid uses this ability, imagine one being pursued by a large fish. If the squid is dark at first, then becomes pale, and at the same time suddenly changes its direction, the fish is likely to be left confused and without a meal.

Inky smokescreen The squid has a further strategy to evade predators: the use of its ink. Many people think that the ink is used as a kind of smokescreen in which the squid hides, but this is not the case. The ink is used as a decoy. A dark squid ejects some ink and at the same time turns pale and darts off in a different direction, leaving a would-be predator chasing the ink while the squid escapes.

The ink is contained in a sac on the roof of the mantle cavity. When it is ejected it is passed through the funnel and mixed with mucus. The purpose of the mucus is to hold the ink together in a blob about the same size as the squid, and it also seems to act as a chemical attractant to the attacker.

Squid reproduction The general facts about how squid reproduce are much the same for all species, though there are differences in details. For the common squid, which is widespread around the south coasts of England, the breeding season starts in April. To mate, the male and female meet head on and, while their arms are interlocked, the male inserts one of his arms inside his mantle cavity and grasps a capsule of sperm called a spermatophore. This he inserts into the female's mantle cavity to fertilise her eggs. After the eggs are laid, the adults usually die.

The eggs are laid inside finger-like masses of jelly on rocks, or some other hard surface. They are left to hatch into tiny squid a couple of millimetres long. The young grow rapidly and, within a year or two, are themselves ready to reproduce and die.

British squid The common squid is one of our smaller species, reaching perhaps 45cm (18in) long. Its streamlined body is ideal for darting here and there, yet it is also capable of slow, refined movements by carefully undulating the fins along the sides of its body.

A faster species is *Onychoteuthis banksi*. This is a small squid that darts through the surface waters of the open sea. It catches its prey with vicious tentacles, in which the suckers have become modified into sharp, curved claws.

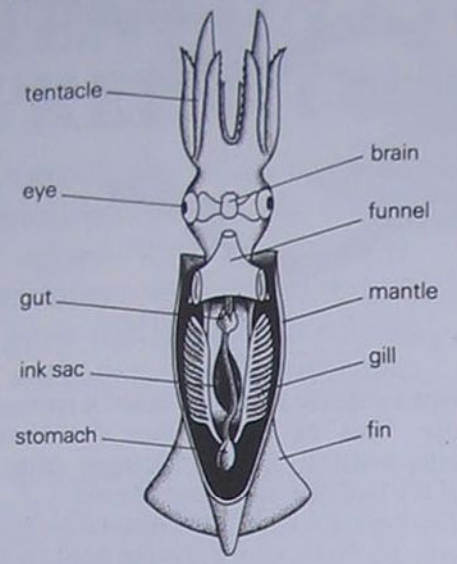
Among the largest squid to be found around our coasts is a group known as *Ommastrephes*. They may be several feet long and are occasionally seen stranded on beaches.

Deep-sea squid Some of the strangest squid,

Above: A squid lays its eggs on a rock inside masses of finger-like projections of jelly.

Below: A pair of squid just prior to mating. This takes place head-on with arms interlocked.

Anatomy of a squid



All squid species have much the same structure. The head is attached at one end to the arms and tentacles, and at the other to a tapering cylinder of muscle called the mantle. Lying along the inside top of the mantle is an internal shell—the pen—from which hang the organs. Only a small part of the space inside the mantle is taken up with the organs. Most of it is a cavity that can be alternately filled with water and then evacuated through the funnel to provide the squid with jet-propelled motion.

Above: A squid devouring its prey. All squid are predators, feeding mainly on small fishes and crustaceans. These they catch with their sucker-covered tentacles.

Below: A species of *Loligo* stranded in a north Devon rockpool. A sight like this is rare; squid are seldom found close to the shore.

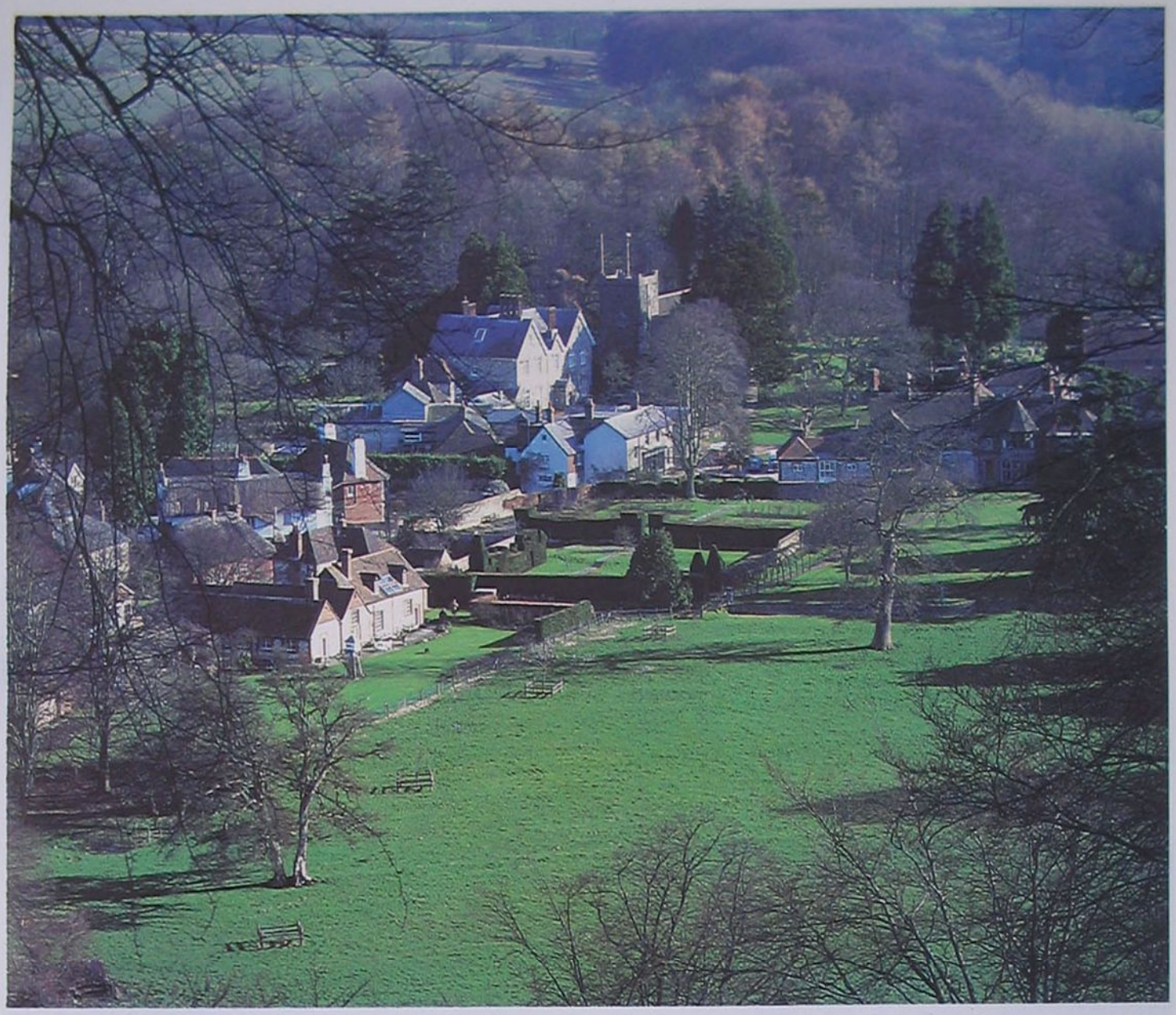
for example, *Histioteuthis*, are found in the deep sea around Britain. As a juvenile, this squid has a pair of eyes much like those of any other squid, but as it matures the right eye becomes almost twice as large as the left. This strange phenomenon has puzzled biologists for many years. Some have argued that the large eye functions in the poorly-lit deep sea and the small one is used for when the squid rises to the well-lit surface. Others have argued that the opposite is true. The problem is still not resolved, but recent observations have shown that *Histioteuthis* orientates itself with its large eye pointing up and the small one pointing down.

Most deep-sea squid are arrayed with light organs, often resembling brilliant jewels. These may be important for communication, recognising mates, or even camouflage.

How can a light organ act as camouflage? Some squid are almost transparent, apart from a few organs which are always opaque. Any creature looking up at a squid from below would see these organs silhouetted against the faint light coming from the surface. However, with light organs placed just below the opaque areas and giving off the right amount of light to balance that coming from above, the squid becomes invisible.

Squid for food Most people regard squid as being little more than curiosities, yet they could have economic importance as food.

The reason lies in the decline in numbers of one of their major predators, the sperm whale. It has been estimated that, in 1972, about 320 million tons of squid were eaten by sperm whales, compared with an annual figure of about 800 million tons some 35 years earlier. So there could be about 500 million tons of squid 'available' for human consumption each year. Since our current annual world catch of fishes is between 60 and 70 million tons, the potential of squid as a food source becomes clear. To date, however, many squid found in the stomachs of whales are unknown species that we have never been able to catch.



THE NATURALIST OF SELBORNE

In 1789 a remarkable book was published – Gilbert White's *Natural History of Selborne*. Simply a series of letters about the wildlife in and around Selborne parish, it has become one of the most widely read books in the English language.

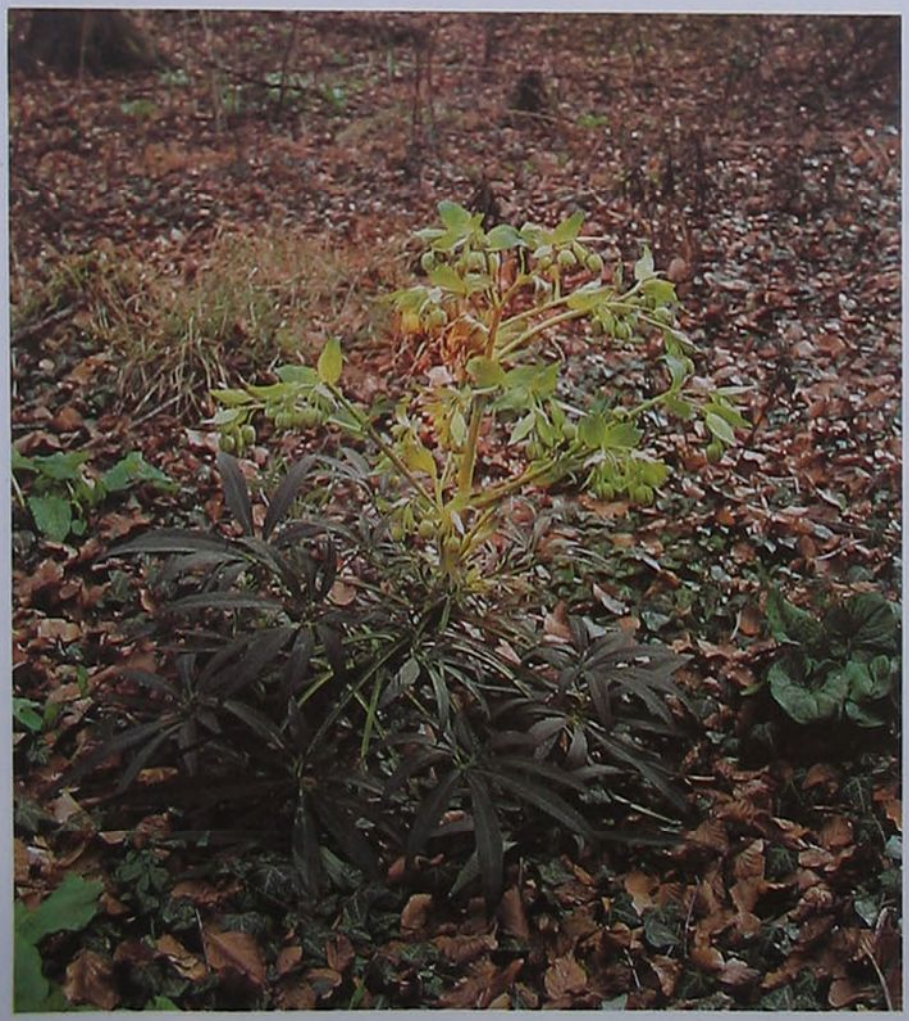
Above: The village of Selborne, viewed from the beech hanger. Gilbert White's house, 'The Wakes', is on the right, opposite the church. Gilbert White was a country parson who spent most of his life in Selborne and knew the area well.

The extraordinary appeal of Gilbert White's *Natural History of Selborne* depends both on the penetratingly accurate observations of the author, and on the variety and attractiveness of the area to which it refers.

The parish of Selborne lies in the north-east of Hampshire, on the western edges of the Weald. The village itself, though pleasant, is not exceptionally picturesque; it is the countryside around the village that is so special, containing almost all the features that one could expect to find in rural lowland England. The steep slopes tumbling down towards the Weald and the rapid changes of underlying rock give rise to a series of different landforms and habitats: above the village rises the steep beech hanger on the chalk scarp, ascended by White's famous zig-zag path; above this, stretching away to the west, is the now-wooded Selborne Common on the poorer soils of the plateau; and to the south lie areas of chalk downland. Below the village, the ground falls away into a complicated valley system, with steep unimproved pastures, hanging woods and copses and the more fertile fields of the valley floor. Eastwards and northwards there is a dense belt of woodland, separated by damp pastures, lying over the gault clay. Finally, going further eastwards, there are the heaths, bogs and ponds of the old Royal Forest of Woolmer, now mostly military property, and no longer in the parish of Selborne.

Part of the secret of Gilbert White's appeal to so many generations of readers is that he was never satisfied with any observations he had not made himself. He always investigated subjects for himself, no matter how long it took. The illustration (above) shows him with his tame bat, which he studied for hours on end and which would take flies out of his hand. He was the first to discover the presence in Britain of the noctule bat.

Gilbert White's main interest was birds, and he made detailed observations about swifts (above), including the discovery that they mate on the wing. His notes also enable us to check the locality of plants, like the stinking hellebore (below) which still grows in the beech woods under the hanger at Selborne.



White and his correspondents White himself, a country parson, spent most of his life in Selborne, at his family home 'The Wakes' opposite the church. It is clear from his writings that his duties, with such a small parish population, were far from onerous, and White had ample time for his natural history studies. Selborne at that time (1789) was extremely isolated, with very poor roads in all directions, and White's lifeline to the contemporary scientific community was correspondence. The letters he wrote to the naturalist and explorer Daines Barrington, and to Thomas Pennant, were later to become the *Natural History*, together with a few more written especially for the purpose.

Perhaps the most remarkable feature of White's work is its complete originality and freedom from the shackles of thought of its period. White was not satisfied with any observations he had not made for himself, and disliked drawing conclusions until he had real evidence for doing so. He believed that identifying and classifying living things according to system, which is what most of his contemporaries were doing, was only a basis for more important work, and wrote to Daines Barrington that 'system should be subservient to, not the main object of, pursuit'.

Observations and discoveries White's particular interest was birds, and especially their migration. He was greatly attracted by the swallow family (which then included swifts, though White was already beginning to have his doubts that they were closely related to the swallows), possibly because they were so readily visible around the village.

He gives a detailed account in one letter of his observations of the life of swifts in which, among much general information, is his discovery that swifts may mate on the wing. He went to considerable lengths to find out what they were feeding on when swooping low over pools and streams, and eventually

reported that they were taking emerging caddisflies, mayflies and dragonflies. He also twice untiled the roof of a house within ten days to discover the progress of the naked nestlings within. At the same time, he was ever alert to the possibilities of deductions to be made from his main observations. For example, after noticing that swifts may feed all day long on wet days, often quite high, he deduced: 'first, that many insects abide high in the air, even in rain; and next, that the feathers of these birds must be well preened to resist so much wet'.

He had no trouble in observing house martins and swallows in the greatest detail, and his description of the house martin's nest building is a classic. But he also made a close study of the sand martin, which only occurred around Woolmer Forest in his parish, and was highly frustrated by his inability to see exactly what was happening at the end of the sand martin's long tunnel.

Above: Over the 200 years since White wrote his book, certain changes have occurred. The field crickets he studied no longer appear anywhere at Selborne.

One of White's better-known discoveries, brought about by close field observation, was the distinction between the three resident species of leaf-warbler—the willow-warbler, chiff-chaff and wood-warbler (above). Although sure of their differences by virtue of their songs and habits, White confirmed the fact by procuring specimens to observe. It is interesting, though, that he apparently did not distinguish between the garden warbler and the blackcap which, despite their similar songs, are very different in looks.

Right: The bird's nest orchid is one of the plants that still grows where White described it.

White also took a great interest in mammals, although the area was not especially rich in species. He was the first to discover the existence of the harvest mouse, providing an excellent description of its life history, and he was also the first to discover the presence of the noctule bat in Britain.

The migration controversy There is one subject to which Gilbert White returned time and time again, but which he never fully solved. It does, indeed, seem to be the one subject where his reasoning was less penetrating than usual. At the time that White was writing there was much debate on the extent to which birds migrated, and whether some or all of them remained in Britain in 'hibernacula', only emerging with the onset of warmer weather.

White made many accurate and original observations on migrating birds and, as usual, was very close to the truth. It is noticeable, however, that where an observation gave rise to two possible answers, he almost invariably chose the one that indicated that birds hibernated here, or at least that some of them did. For example, he correctly observed that the plumage of swifts became faded during the summer but was always glossy and dark when they returned in spring; he deduced that, had they spent the winter in a warm climate, they would return equally as bleached as when they went away; therefore he considered that they were more likely to 'retire to rest for a season' and moult there to emerge the following year. (In fact, they moult twice a year.) He spent much of his own time, and hired many local men to assist him, in digging out likely hibernacula and poking about in possible hiding holes. Yet, despite his negative results, he remained certain that some birds did hibernate rather than migrate.

It is strange that White never really reached the correct conclusion, for quite early on in his career he discovered that birds *did* migrate. For example, he frequently observed parties of ring ouzels passing through Selborne in spring, going north, and returning again in autumn. He wrote to Pennant, who lived in Flintshire, enquiring whether ring

ouzels stayed there for the winter. Pennant, unfortunately, replied that they did, and this may well have distracted White from the truth somewhat, though it is clear that he was never really happy with Pennant's statement. At all events, White's observations of migratory birds were numerous and accurate, even though he was in error over the issue of migration.

Changes in and around Selborne One of the most interesting aspects of White's work is the way in which it allows us to chart the changes in species and habitats over a 200-year period. He gives an excellent description of the countryside around Selborne, with information on many of its inhabitants, including the insects and plants. There have been many changes since White's day, though they tend to lie more in changes of detail than in enormous upheavals. The Selborne area has probably changed less than almost any other comparable piece of lowland England.

A few hundred yards behind the church at Selborne lies an area of woodland known as the Short Lythe. In White's day this was a 'steep abrupt pasture field, interspersed with furze', and it was remarkable in that it abounded with field crickets, which White studied in some detail. The habitat has since become unsuitable for the crickets, and these insects are now no longer found anywhere at Selborne; it is, however, clear that this is part of a much wider decline, probably partly induced by climate, for the field cricket now only occurs in two colonies in the warmest parts of southern England.

White also picked out a number of the rarer plants of the district, and in many cases his descriptions allow us to check the exact locality. Several still remain, growing under almost identical circumstances: for instance, green hellebore still appears in Dorton Wood, while stinking hellebore and bird's nest orchid still grow under the beeches in the hanger, and small teasel flourishes by the stream in the Lythes below the village. Others, however, have gone, sometimes because their habitat has changed, like the toothwort, or in a few cases because they have been dug up, as is almost certainly the case with the rare and beautiful mezereon which can no longer be found in Selborne Hanger. Others seem to have disappeared for no obvious reason.

In other cases, White provides particularly detailed descriptions of stretches of country, his writings on Woolmer Pond being an excellent example. He recorded that this pond (almost certainly one of the few natural lakes left in southern England) had a circumference of almost 1½ miles, with an area of about 66 acres. He also noted that it had a naked sandy bottom. Today, the pond itself is only a few acres in extent, reduced by a combination of altered stream flow and hydrology and a gradual encroachment of marsh and willow carr.

Above: Yet another first for Gilbert White was the discovery of the harvest mouse—a species for which he provided an excellent life history.

Right: One plant described by White is no longer present in Selborne. This is the rare and strange-looking toothwort, a species that has no chlorophyll (hence its pale colour) and is parasitic on hazel, elm and poplar.

Below: Gilbert White's famous beechwood hanger at Selborne Lythe.

FLOWERS OF DRY PASTURES

Over the centuries, Britain's pastures and meadows have been created from cleared forests. Many of the plants and flowers that grow in the drier grasslands were once planted as fodder crops, or are able to survive constant grazing of the land.

Above: A field full of daisies (*Bellis perennis*) flowering in Dorset in May. When the first flush of these flowers appears in late spring they can quickly cover an entire field. As the daisy is only a small plant, it usually flowers only where the grass is short, due to close grazing or cutting as on a lawn.

Most of Britain's grasslands can be classed as artificial in the sense that our islands were once almost completely covered by forest. Around 5000 years ago, man started to make temporary clearings in the forest, cutting and burning the trees and making ash to fertilise the ground for his crops. Gradually, this type of agriculture gave way to more extensive clearance of upland sites where tree growth was less vigorous. Wild grasses and other plants colonized cleared sites, providing grazing for domesticated animals and forming Britain's first pastures. With the improvement of agricultural methods, notably the invention of the Anglo-Saxon eight-ox plough, the richer soils of the river valleys were cultivated. Many of the upland sites cultivated earlier were turned over to animal grazing instead.

The Saxons worked with large, open fields divided into strips by shallow ditches, the remnants of which may still be seen in some areas. Today's patchwork of fields, divided by hedgerows or walls, is largely a result of the enclosure acts of the mid 18th and early 19th centuries. These acts were mostly concerned with the enclosure of land in central and southern England, so areas to the east, west and north often show quite a different pattern of fields.

Grassland features The common feature of each type of grassland–whether river valley, chalk downland, heath, or dry lowland pasture–is that the plants are grazed or, in the case of hay-meadows, cut. Grasses are able to grow well under these conditions as they are monocotyledonous plants and grow from the base. Even after a grass leaf has been cut in half, it can still grow from below. Most dicotyledonous plants cannot survive such repeated damage as the growing points at the tips of the leaves and stems are removed by grazing and cutting.

However, some species have special features that enable them to survive this constant grazing and cutting. They produce a rosette of leaves or tuft of stems close to the ground, or are able to produce new stems from underground storage organs.

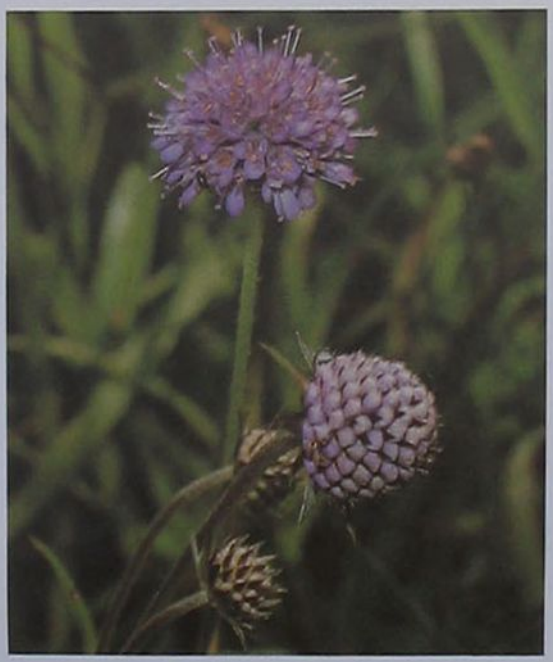
Right: **Sorrel** (*Rumex acetosa*). Flowers May to June. Height to 1m (39in).

Above: **Cat's ear** (*Hypochoeris radicata*). Flowers June to September. Height to 60cm (2ft).

Above: **Lady's bedstraw** (*Galium verum*). Flowers July to August. Height to 1m (39in).

Above: **Alfalfa** (*Medicago sativa*). Flowers June to July. Height to 90cm (36in).

Right: Field scabious (*Knautia arvensis*) and, below, greater knapweed (*Centaurea scabiosa*) are two common species of summer grasslands. Both bloom from July to September and are often found growing together. Field scabious takes its name from its former use in treating the disease scabies. Another, more descriptive, name for the species is 'pincushion', which aptly describes how the stamens stand stiffly erect above the domed flower head. Greater knapweed is a member of the daisy family, and has tough, wiry stems which make it unpalatable to cattle.



Grazing-resistant species Ribwort plantain, one of several species of plantain common in various types of grassland, is resistant not only to grazing but also to trampling and is thus a familiar plant of lawns. It has a rosette of leaves with prominent, parallel veins, to which the common name refers. The flowers are produced in a compact head on the end of a long, wiry stalk and are pollinated by the wind.

The lady's bedstraw does not have a basal rosette of leaves but spreads by numerous underground stems produced from a creeping rootstock. The exact appearance of the plant depends on the height of the surrounding grasses which support the bedstraw's weak, clambering stems. The common name refers to the plant's former use in bedding, where it was valued for its honey-like scent, the smell of new-mown hay given off by the dried foliage, and its apparent effectiveness against fleas.

A species valuable to our ancestors for culinary reasons was sorrel. Its sharp, acidic taste gave a characteristic flavour to fish, although the large-scale importation of lemons into this country has led to a decline in the use of sorrel. It is a close relative of the docks and, as it grows from strong, underground tubers, it is a grazing-resistant species.

Fertilisers and fodder plants Sometimes old grassland with low productivity is ploughed in and resown to make new pastures or hay-meadows. Arable land may be resown as temporary grassland as part of a crop rotation to restore the fertility of the soil. The grass is often cut for hay at first, but later animals may be put out to graze on it. Farmers are no longer content to rely on the wild grasses and weeds that invade untended land and various higher-yielding strains of grasses are sown together with forage plants belonging to the pea family. Plants of a particular species may be so numerous that the entire field takes on the colour of the flowers.

Records show that red clover has been sown as a fodder crop for cattle since at least 1645. More vigorous strains have been developed gradually, and the modern cultivated plants differ from wild plants in their hollow stems and in leaflets which lack teeth on the margins. The plants can be ploughed in for green manuring, their root nodules further enriching the soil.

Other similar species of clover are sometimes cultivated, such as the aptly named zigzag clover with its zigzag stems, and the introduced crimson clover. The native white clover is also familiar in grassy places, particularly where the grass is closely grazed or cut, and is rarely cultivated. The stems differ from those of red clover as they creep along the ground, rooting and sending up flower stalks at intervals, each bearing a rounded head of white or pink flowers.

The hop trefoils are less familiar clovers; not because they are any rarer, but because

the flowers are less conspicuous. The yellow petals of the hop trefoil (*Trifolium campestre*) wither, but remain attached to the developing fruits. The brown, papery remnants of the the petals give the fruiting head the appearance of a small, upturned hop, hence the common name of the species.

A species easily confused with the hop trefoil while in flower is the black medick (*Medicago lupulina*). As soon as the fruits develop, however, the two species are easily distinguished. The petals of black medick fall after fertilisation to reveal the head of black pods which gives the species its common name. Black medick has been used as a fodder plant in the past, and still is in some parts of Europe, but a much more important species in this respect is the closely related alfalfa, or lucerne. This species has been deliberately introduced into Britain as a crop, and the plants produce abundant seed, spreading rapidly into neighbouring grassy areas.

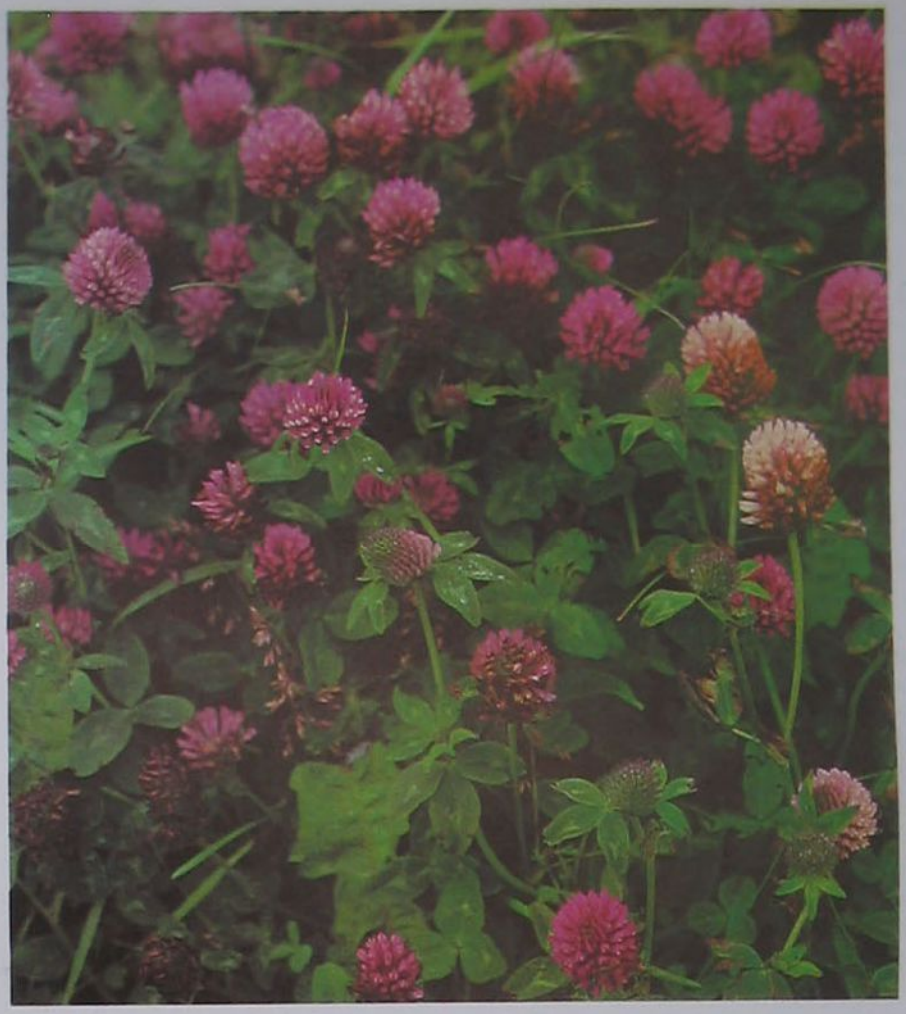
Grassland daisies Many species of the daisy family are also found in grassland. Each flower of the daisy itself is actually composed of numerous florets; the yellow, tubular ones in the centre of the flower are known as disc florets while the florets round the edge have a long, strap-shaped white petal on one side and are known a ray florets.

Some species of the daisy family have only one sort of floret; the dandelion, for example, has only ray florets. Many other yellow-flowered members of the daisy family, growing in similar grassland, also have only ray florets. The cat's ear is one example. This is usually a much taller plant than the dandelion, with a rosette of lobed leaves at the base of the branched flowering stems.

The dandelion flowers sporadically throughout the summer and into the autumn. It is quite nutritious for cattle, and the plants are also used by man. The leaves and flower buds can be eaten in salads; the dried, ground root makes a coffee substitute and the florets can be turned into a potent wine.

The milfoil or yarrow (*Achillea millefolium*) is a grassland daisy with quite a different appearance. It has small flower heads, each composed of disc and ray florets clustered together in characteristically flattened heads which give the impression of a single, large flower. The flowers are usually white or pink, but rare, purple-flowered plants may be seen. It is a deeply rooted species and survives constant cutting. Normally, only the flowers are lost, and these grow again quickly.

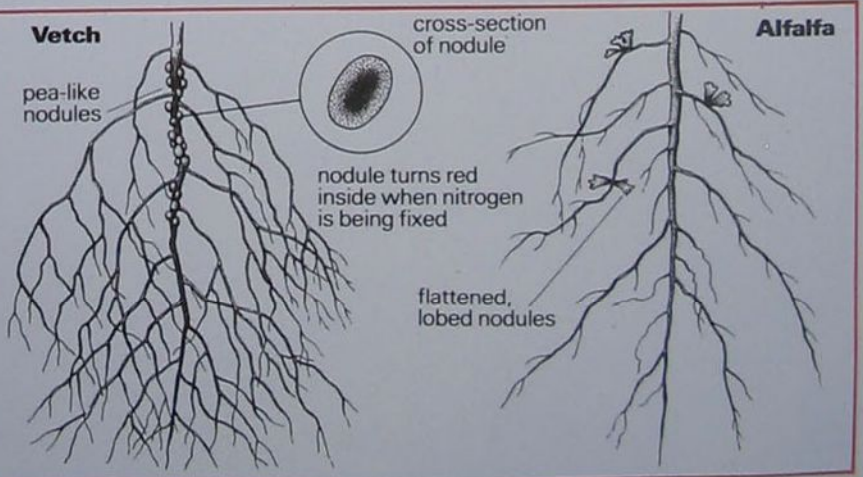
The common name of the milfoil refers to the feathery leaves, each divided into numerous fine segments, and means 'thousands of leaves'. Milfoil has had a great variety of medicinal uses and is still sold in herbalists' shops for home use. In fact, the Latin name *Achillea* refers to the legend of Achilles, who is reputed to have cured his soldiers' wounds with milfoil.



Above: Red clover (*Trifolium pratense*) has a plentiful supply of nectar, which you can taste if you bite and suck the base of one of its florets. For this reason, red clover is sometimes known as honeysuckle, or honeystalks. The flowers, which appear from May to September, are attractive to honey bees as well as bumble bees and many other insects. One method of identifying the species is by the pale V-shaped band appearing on each pointed leaflet.

Nodules for nitrogen

Many species of the pea family bear small nodules on their roots, caused by bacteria which enter via the root-hairs. These bacteria are able to 'fix' nitrogen from the air, eventually turning it into nitrates—a valuable plant food. Clovers, vetches and alfalfa are often sown as crops and, by ploughing in the whole plant or just the roots, the farmer is able to improve the soil's fertility. Wild species of the pea family are also encouraged in pasture, both for their nitrogen-fixing ability and for their protein-rich seeds, which make them valuable as fodder.



STRANGERS ON THE SHORE

A close look at the jetsam the sea deposits on the shore can reveal a number of rare and beautiful invertebrates–some are unusual British species but others are exotic creatures driven thousands of miles off course by sea and wind.

Below: Some of our most unusual marine visitors are brought here from thousands of miles away on the North Atlantic Drift, to be blown the last few miles ashore by a south-westerly wind. The best part of the country to find these stranded exotics is along the south-west coasts–Cornwall, Devon, South Wales and south-west Ireland.
The piles of seaweed along the strandline of this beach on St Martin's, Isles of Scilly, are an ideal hunting ground.

One of the hazards facing animals living in the sea is the possibility of being washed ashore and left stranded to die. Some, mostly fishes and whales, become stranded through poor navigation. Others, particularly many species of invertebrates which have no independent means of locomotion, simply drift along at the mercy of the sea's currents and winds and inevitably are sometimes washed up on shore.

Most invertebrates washed up on British shores are, of course, native species.. But many others have drifted great distances. Britain is well placed to receive these drifting exotic species, for it lies at the eastern end of the North Atlantic Drift. This is a powerful sea current that starts in the Caribbean Sea as the Gulf Stream, travels up the east coast of the United States and then swings eastwards across the North Atlantic to the west coast of the British Isles.

The Gulf Stream acts like a river, carrying exotic creatures thousands of miles from the Caribbean to within close reach of our shores. Given a south-westerly wind, large numbers may be driven the final few miles on to our coast and stranded there.

Jack sail-by-the-wind One of the exponents of the drifting way of life occasionally found stranded on our beaches is a jellyfish-like animal with the delightful name of Jack sail-by-the-wind, or by-the-wind sailor. On the beach, this creature could easily be mistaken for a blue plastic disc. On the sea, however, this disc acts as a float, carrying on its upper surface an erect triangular sail to catch the wind, and on its lower surface a mass of polyps and tentacles for reproduction, digestion and stinging prey.

Jack sail-by-the-wind is not a single animal but a colony made up of many individuals. For that reason, it is not classed with the jellyfishes, which are all single animals, but as a hydrozoan along with other colonial jellyfish-like animals such as the Portuguese man-o'-war.

Unlike true jellyfish, which move through the water with a pulsating motion, Jack sail-by-the-wind uses its sail to harness the wind.

The chances of it being washed ashore are reduced by the fact that some individuals have the sail angled to swim to the right while others are designed to swim to the left. Even given an unfavourable wind, therefore, not all the members of a fleet would be washed ashore.

The most likely place and time to discover Jack sail-by-the-wind stranded on the beach is along the south-west coast after persistent south-westerly winds. You may possibly see thousands, representing an entire fleet wrecked on the shore.

Violet sea snail The same south-westerlies may bring a rare visitor to our shores, the violet sea snail. This is a carnivorous gastropod that normally lives in the surface waters of the subtropical parts of the Atlantic Ocean. It drifts along clinging upside-down to a raft made of a tough mucus bubble which it secretes. As it drifts, it encounters its prey by chance, Jack sail-by-the-wind being one of its victims. The violet sea snail feeds on the tentacles, often leaving nothing but the tell-tale horny float.

On the beach it is well worth examining Jack sail-by-the-wind in case it harbours a violet sea snail – both creatures victims of the same wind, usually in the summer. The shell of the violet sea snail is a strikingly beautiful lavender-blue.

Exotic squid Drifting invertebrates are most susceptible to being stranded, but the same fate can also occur to invertebrates with their own means of propulsion. Particularly notable among this group are species of large exotic squid that sometimes inadvertently enter British waters and become stranded. The two most familiar examples are *Ommastrephes caroli* and *O. pteropus*, both of which can grow up to 2.5m (7ft) long. These squid probably enter the North Sea from the Atlantic, only to find our winter conditions too severe. They die and are washed ashore, notably around the Firth of Forth and the Yorkshire coast.

There is a truly giant squid called *Architeuthis* which is very occasionally found washed ashore. This species can be as long as 20m (60ft) and weigh perhaps a ton. Little is known about this creature but it is thought to live deep down in the sea on the edge of the Continental shelf. Its fins are relatively small, which suggests that it is not especially active, and its flesh is known to be buoyant. So perhaps *Architeuthis* spends much of its time suspended in the sea waiting for prey to come within striking distance.

Above: Occasionally the wind blows a fleet of Jack sail-by-the-wind on to the south-western shores of Britain and hundreds become stranded, leaving only their round blue floats.

Below: A rare giant squid (*Architeuthis dux*) found washed ashore at North Berwick in 1977. The overall length of this specimen was 6.5m (21ft) from tail fin to the end of its tentacles. Of this, the body and head together were 2m (6½ft) long.

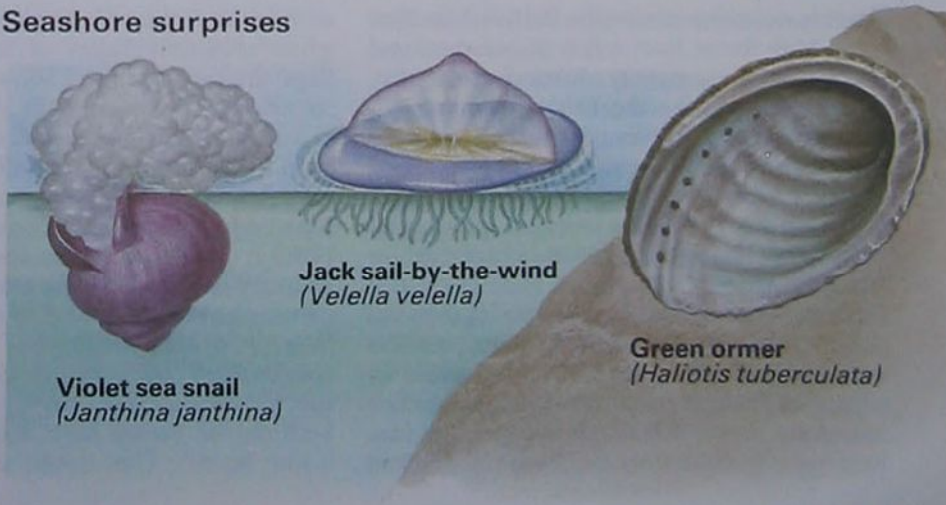
Native beauties Creatures like Jack sail-by-the-wind, the violet sea snail and giant squid seem especially thrilling because of their exotic origins. But there are many British invertebrates that are exciting to find on a beach because they are hardly ever seen, living as they do hidden around the low-water mark.

An example is the cowrie. There are two tiny species of cowrie found along our southern coast. Though they are British species, their shells have the same characteristic shape as the larger tropical cowries.

One particularly beautiful shell is a treasured find. The green ormer is a large oval univalve, about 8cm (3in) long, which occurs only in the Channel Islands. The outside of the ormer is reddish-brown or greenish; the inside surface is a shimmering rainbow-coloured mother-of-pearl. The edge of the shell is punctuated by a series of small holes.

The ormer can be found clinging to rocks at or below the lowest tidal level. Between December and April the islanders gather this mollusc for its delicious meat.

Seashore surprises



MOUNTAIN AND MOORLAND MAMMALS

Many of our native land mammals are so highly adaptable that they can live almost anywhere in Britain. Some of them flourish on high moorlands despite the long cold winters, rather sunless damp summers, and unkind soils. Even so, none belongs exclusively to the uplands.

There is no mountain in the British Isles that is too high for at least a few of our mammal species. The tiny pygmy shrew, for instance, has been found at the top of our highest mountain, Ben Nevis; but most of our mammals thrive in a variety of habitats, and even the mountain hare, though so much at home on the Scottish moors, is found elsewhere on low-lying ground, notably in Ireland.

Mountain hare This hare is smaller than the much more widespread brown hare; its ears are shorter, and it tends to turn white in winter while the brown hare stays brown. The mountain hares of Ireland, however, seldom turn wholly white; some become patched with white, others show no white at all. The white mountain hares of Scotland camouflage themselves in the snow to be less conspicuous to predators, but in Ireland, which lacks a steady winter snow cover, there is no need for this type of camouflage.

Although the brown hare is generally regarded as a lowland animal, a small proportion of its population lives on moorland up to about 500m (1500ft), where, in Scotland, its range overlaps with that of the mountain hare. It seems likely that when the two species meet they compete for food, and that the mountain hare keeps to the uplands because the brown hare is dominant at the lower levels. This could explain why in

Above: Red deer. There are thought to be about a quarter of a million in northern Scotland. They live in far-scattered herds, usually numbering two or three dozen, but occasionally they assemble in larger numbers and up to 600 have been seen together. They are red only in their thinner summer coats; in winter the pelage is longer and browner. They prefer life on the high moors in summer to avoid flies, but in winter they are driven by cold and hunger to seek food and shelter in valley bottoms and woodlands.
Originally the red deer were forest dwellers, so those that live today up on the moorlands are really refugees. Subsisting for many generations on a diet of heather and coarse grasses has reduced the body weight and antler size of the Highland deer compared with that of those living in southern England.

Left: The mountain hare. Because mountain hares, like red grouse, prefer to feed on short, young, heather, they are commonest on the Scottish moors carefully preserved for grouse, for there the heather is systematically burned to keep it short. Elsewhere they graze on grasses and sedges and, in times of deep snow, can survive on gorse, juniper, and other tall plants. Their commonest natural predators are foxes, but some are seized by wild cats, eagles and other raptors. Leverets are taken by buzzards and hen harriers. By far their worst enemy is man. He has long persecuted them for sport and because they eat the heather shoots which are meant for grouse.

Ireland, where the brown hare is largely absent, the mountain hare flourishes in lowland areas.

Upland rodents The hares' small cousins, the rodents, are also well represented on the uplands. Indeed one, the field vole, must at times outnumber all the other mammals put together. This little vole, grey-brown with small eyes and ears, short tail and blunt snout, occasionally multiplies in numbers so astonishingly that its multitudes eat the grass down to the bare earth. This plague of voles attracts predators from afar – hawks, owls and carnivorous mammals. Then quite suddenly a virulent disease runs through the famished vole population, reducing it to a low level, the predators quickly disperse and the episode is over. This vole is a hardy species on all levels of moorland, reaching 1300m (4000ft) on the Cairngorms. It feeds mainly on grasses and thrives especially in the deep grassland that develops when sheep are fenced out of moorland in preparation for tree planting.

The bank vole, distinguished by the redness of the adult pelage, though predominantly a lowlander of woods and hedgerows, is also locally recorded on high moorland. Likewise the wood-mouse is by no means restricted to woods. Just as aptly described by its alternative name, long-tailed field-mouse it, too, is often a grassland dweller, occurring here and there on upland moors.

Our two smallest mammals also include the high ground in their range. Both pygmy and common shrews live well hidden in the grassland, feeding on worms, beetles and other invertebrates. They are voracious species that need to eat frequently to sustain their night and day activity that continues even in winter, when invertebrate life is often hard to find.

The water shrew, which is a neat black colour above and white below, in contrast to the other two shrews which are brown on the back, is, like the common shrew, distributed throughout mainland Britain. Far better known as a lowlander than as an uplander, the water shrew occurs only sparsely on moorlands and perhaps seldom moves above about 300m (1500ft), frequenting instead stream banks and the margins of lakes.

Hedgehog and mole Two other insectivores, the hedgehog and mole, also belong chiefly to the lowlands but both venture up the valleysides to the moorland rim in fair numbers. Occasionally you see the prickly skins of hedgehogs far above the tree line, but these may have been animals carried up by predators. Moles have a much better claim to be genuine dwellers on high moorland, for they have been found living at 100m (3000ft). These occurrences are rare, however. The mole is dependent on an abundance of easily available earthworms and cannot tolerate soils that are either waterlogged, extremely stony or very sour, because they are all virtually wormless. As such soils prevail over wide areas of moorland the mole is inevitably scarce and local there.

Above: The Scottish wild cat, once widespread in Britain (but never in Ireland), was exterminated nearly everywhere by the numerous gamekeepers of the last century. Its original habitat was forest and it still lives in high-level Scottish pinewoods wherever it can find them. Elsewhere it makes do with open country, especially heather moors. Its den is hidden among rocks, fallen tree trunks or deep heather.

Upland carnivores Six carnivores regularly frequent moorlands but they are seldom observed and are most often detected by their signs. Rather common throughout most British and Irish uplands, and quite likely to be seen by day is the fox, because in warm weather it likes to sleep out in the open where it is sometimes disturbed by hill walkers. Its droppings often contain hair, wool or feathers and tend to be blackish when fresh, bleaching to white eventually. Like those of many moorland carnivores, they are often purple with bilberry juice in summer.

The fox lives as readily among steep cliffs

and block scree as among level tracts of tall heather, or the cover of rushes and purple moor-grass. If you search around with binoculars from a high vantage point you can sometimes spot a fox lying curled up sunbathing on a mountain ledge or on the sheltered slope of a peat-hag. Shepherds suspect the fox of preying heavily on lambs and they kill it whenever possible, although the mortality of upland lambs is often high through natural causes. The moor fox lives mainly on small mammals, birds, fruit and any sort of carrion.

The wild cat and four members of the family Mustelidae also regularly live on moorlands. Man's hand has long been against stoats and weasels but the polecat and the pine marten have been even more ruthlessly persecuted; the polecat is now found only in Wales and the Welsh Marches, and the pine marten still thrives in northern Scotland, and areas of Ireland, with smaller numbers in the Lake District and Snowdonia. Both are by preference woodlanders that have adapted to other habitats over the centuries as the tree cover has been destroyed. Both have doubtless been helped by the great spreads of conifers which have invaded the moors this century and provide cover and food.

The red deer, the largest and most celebrated of the moorland mammals, was originally a forest dweller, as was the much smaller roe deer which remains a shy woodland creature nearly everywhere. But in the Scottish Highlands the roe deer has to some extent followed the life-style of the red deer and taken to the treeless uplands in summer, especially where it can find the cover of tall heather. In at least one district roe deer live above the tree line all year. Scottish roe deer are indigenous, as distinct from those of lowland England which are the result of introductions from the Continent. There are no wild roe in Ireland. It is interesting that although Wales has large areas of moorland it has no deer of any sort. There used to be plenty of red deer, but they were exterminated centuries ago and have never been reintroduced.

Above: Part of a herd of reindeer which have been on the Cairngorms since 1952 but which, managed like cattle, cannot be thought of as even semi-wild. Other alien moorland mammals include feral goats, Soay sheep, the small troop of escaped red-necked wallabies in Staffordshire, and a few strayed rabbits and squirrels.

Below: A stoat, a ferocious, usually lowland species, can sometimes be found in upland areas.

THE ENTERPRISING LITTLE RINGED PLOVER

As years go by, more and more little ringed plovers visit Britain in spring, ever since they first came in 1938. These birds are highly adaptable, and many pairs abandon their usual haunts on sand and shingle, intrepidly colonizing dry gravel pits, reservoir banks and other man-made habitats.

Above: Little ringed plovers inhabit dry, sandy areas, often inland. The three 'ringed' species of plover may all be found in similar habitats, and where the three nest in the same neighbourhood, birds of each species defend their territories against one another. Thus it may be for the sake of avoiding competition that little ringed plovers leave the coastal sites and nest inland.

Fifty years ago, little ringed plovers were rarely seen in this country; although they nested not far away on the Continent, their migration route took them southwards into Africa for the winter, and so they had little cause to come to Britain. Today, after a remarkable success story, we have several hundred breeding pairs.

Slowly spreading The recent and still continuing spread of these smart little wading birds is a result of their own adaptability and of man's help in opening up new habitats for them. For nearly a whole century they have expanded their breeding range in a north-westerly direction, so that they can be found in almost every European country, and right across Asia to China and Japan. Typical habitats of the little ringed plover are sand and shingle banks beside lakes and rivers, but when the birds reached Britain they were quick to adapt to the very similar man-made alternatives: mostly gravel pits and reservoir banks.

Our first pair of little ringed plovers nested at the Tring reservoirs in Hertfordshire, in 1938. In 1944 a second pair was located, and the population has increased steadily ever since. There were over 100 pairs by 1960, over 200 by 1967 and over 400 by 1973; and they are now firmly established in most central and eastern counties of England; some have been found in North Wales and even in Scotland.

The seven species of plover The little ringed plover is one of seven species of plover which you are likely to find in Britain or close by in France. All are compact-looking birds with medium-length legs, short necks and short, slightly bulbous beaks. Only one, the grey plover, has never nested in Britain, though it is a common winter visitor from Russia and Siberia to many coastal areas. The golden plover, which has a very similar plumage to the grey, breeds on the hills and moors of north and west Britain. The lapwing (or peewit) is the familiar 'green plover' of grassy farmland; and the dotterel is, in this country, a rare bird that breeds on only a few remote mountain tops.

The three remaining plovers all have 'ringed' plumage and are easily confused with one another. The Kentish plover has an incomplete black breast band and pale sandy upperparts. Although it no longer nests in Britain – the last regular pair bred in Sussex in 1956 – it remains common on other European coasts, and is still occasionally seen here.

Finally, the ringed and little ringed plovers, both with complete breast bands and pale brown upperparts, are so similar that even experienced ornithologists sometimes mistake them. At 15cm (6in) long, the little ringed is the smaller of the two; it is also more lightly built and has a finer bill, but at a distance and unless the two species are close together so that a comparison can be made, these differences are unreliable guides. In general, the little ringed plover is seen inland and the ringed plover on the coast, but again this is not a diagnostic feature.

The best way to identify the little ringed plover is to watch it flying and listen to its calls. Unlike the other 'ringed' plovers, it has no conspicuous wing bars – the wings appear completely brown – and its call is a short, characteristic descending whistle – 'pee-u'. In a really close view you can see that there is a yellow eye ring and a white stripe extending right over the crown – features not found on ringed or Kentish plovers. Also, the little ringed plover has a blackish beak (the ringed plover's beak has an orange base) and flesh-coloured legs rather than orange-yellow as in the ringed, or black as in the Kentish plover. Immature individuals of all three species are much less distinctly marked, for example all have incomplete breast bands, so they are even more difficult to identify.

Settling to breed The first little ringed plovers arrive in mid to late March, but most arrive in April. Their first task is to find a territory: a place with some shallow water by which to feed, and a dry, stony or muddy area in which to nest.

Although males and females have identical plumage, you can spot the male when he lays claim to the territory with his noisy and conspicuous display flight, in which he flies about with curiously slow beats of his fully outspread wings, constantly calling out his trilling 'treea treea treea' song.

The male also takes the initiative in nest building; forming a hollow in the ground by squatting down, leaning forwards and rotating on the spot while at the same time scratching backwards with his feet. Attracted by the male's activities, and by his conspicuously fanned black, brown and white

Little ringed plover (*Charadrius dubius*); small wader; summer visitor (March-Aug). Length 15cm (6in).

Below: The scrape nest of a little ringed plover, in a typical site – a sandy, dry piece of flat ground. Newly dug gravel pits, often those still being worked, are ideal. Some choose natural sites beside lakes or rivers, but others make do even with industrial waste ground, where pools of rainwater provide sufficient insects and other invertebrates to keep the birds well fed.

Above: A nesting pair, changing over at the nest while incubating. The birds squat close together over the nest and make the change without interrupting the warmth and cover for the eggs. In doing so, they avoid exposing the eggs to the view of hungry predators.

Below: On hatching, the chick already has acute hearing and sight, fully formed legs and a warm coat of down. As soon as the coat has dried, the chick can walk and feed itself. Its parents lead it to the best feeding place, and, if danger threatens, whistle the alarm. All young chicks react to this sound, crouching motionless and letting their camouflage work.

tail, the female then enters the newly formed scrape–while her mate stands close by, flicking little stones back towards her. The completed nest is often lined with a few plant stems, stones or fragments of shell. In May, the female lays four well-camouflaged stone-like eggs; each is buff-coloured with brown spots.

Hazards abound Little ringed plovers always choose open nest sites on the ground, and are therefore vulnerable to several dangers, and their camouflage, instinct and cunning are tested to the full. They are remarkably tolerant of disturbance by anglers, workmen and heavy machinery in their neighbourhood, leaving their nest only if threatened by a direct approach; but their greatest danger is from the ever watchful crows and magpies, which need only a few seconds to fly in and steal the eggs. At one regular breeding site, this particular problem has been overcome by placing a wire mesh cage over the nest, with holes large enough to allow free passage for the plovers but too small for the crows.

Deceiving the eye Camouflage plays a large part in the life of the little ringed plover. A sitting bird is much more difficult to spot than you might expect. From a side or face-on view, the boldly patterned head and breast break up the bird's outline so effectively that it becomes almost impossible to tell that the bird is there, and from above the mud-coloured back and crown blend marvellously into the surroundings.

Helpless, hungry chicks in an open nest would make easy targets for predators, but when little ringed plover chicks hatch they are already well equipped for survival. Development within the egg continues to an advanced stage, so that within hours of hatching the chicks are able to fend for themselves to an astonishing degree. Within four weeks they can fly.

The little ringed plover's last line of defence is one of cunning–the distraction display. When, for example, a dog threatens to approach too closely to the eggs or brood, the adult plover quietly makes its way round behind the dog. Then with loud calls and conspicuous flapping about on the ground, it pretends to be injured–trailing a 'broken' wing in a manner that entices the dog. In such a situation, most dogs forget the eggs and young, and chase the apparently easy meal, which of course moves away from its family and then escapes with ease.

Methods of hunting All plovers hunt primarily by sight, although they use their sense of touch, too, for you may sometimes see them thrust their beaks well into soft ground. In general, however, they are better adapted for surface food. Little ringed plovers search for insects in the same way that thrushes search for worms: running a few paces and then pausing to scan the ground, and only reaching down when food is in sight.

COLOURFUL STREET TREES

Do you know what trees are planted in your street? Today, the range of street trees is greater than ever before, from exotic cherry trees to unusual varieties of our own native species, all selected to meet the special conditions of the roadside.

Above: Most street trees are deciduous to provide a suitably cheering splash of colour each spring as they burst into leaf and then flower. Very rarely are conifers seen planted along streets, but you sometimes see an evergreen broad-leaved tree, the most common examples being the holm oak and the golden privet. The latter, shown here, forms a small compact tree, growing to no more than 4.5m (15ft) high, which makes it an ideal tree for street planting.

The planting of street trees in Britain began in the middle of the 17th century when the famous diarist, John Evelyn, advocated planting trees in London. Under his direction, trees were planted in several areas of London, including the Mall and St James's Park. During the next 200 years the planting of street trees continued on a small scale, in both London and other British cities, but it was not until the latter half of the 19th century, when the suburban areas began to grow, that street trees became common in residential areas.

Early street trees The first trees planted in London were planes, horse chestnuts and limes. All these are fine trees for parks and large squares, but quite inappropriate in a small street.

In early suburban areas, planes were often planted on both sides of narrow streets, and the subsequent pruning and lopping that was required reduced the trees to a hideous shape. Similarly, horse chestnuts are not the right size for suburban areas, and when pruned their soft wood becomes susceptible to diseases. Common limes share the same problem and have the further disadvantage of attracting swarms of aphids, which leave a black sticky mess that drips on to pavements and parked cars. Moreover, in a dry season, the leaves turn a rusty brown in July and fall from the trees.

What are the requirements? Town planners slowly realised that only certain trees were suitable for street planting. They had to satisfy some fairly stringent conditions.

The most obvious requirement is size, both above and below ground. The branches must not intrude into the road or interfere with overhead wires, power lines or street lights. Nor should the roots be likely to interfere with underground cables, gas or water pipes, or sewers.

It is best if street trees do not bear fruits that are juicy and colourful, otherwise inquisitive children will invariably try to climb them and damage either themselves or a branch. Juicy fruits that fall to the pavement can also be a hazard to pedestrians and attract insects.

Longevity, hardiness to the local weather, compatibility with the local soil and immunity to diseases are also important factors. In connection with the last criterion, it is never wise to plant the same type of tree throughout an area since, in the event of an epidemic of disease, whole streets of trees could die.

One final demand is that the trees should have a long bole, otherwise they could impede the vision of motorists. This is one reason why conifers are rarely planted as street trees–many bear foliage right down to ground level. They also offer the temptation to be taken home for Christmas!

Street cherries Until World War II town planners frequently turned to ornamental cherry trees to provide a splash of spring colour in our streets, and they are still among the most common street trees. Some of the most popular are *Prunus* × *hillieri* 'Spire', which has a suitably narrow growth habit and pink flowers, *Prunus* × *sargentii* 'Rancho', another narrow tree with pink flowers, and *Prunus padus* 'Watereri', which bears long tassels of white flowers.

Many cherry trees planted before the War have suffered badly from subsequent road widening. To accommodate a new road, the trees have often needed to be severely pruned, sometimes becoming lop-sided in the process. The pruning was often carried out at a time when the sap was not rising and so the wounds were susceptible to fungal infections.

Latest trends Most cherry trees are attract-

Left: To make way for buses and lorries this tree had to be severely pruned on one side, leaving it lop-sided and ungainly.

Right: Road-widening has left these trees placed perilously in the road, with the result that they have had to be lopped to no more than a trunk and a few short stumps for limbs.

Below: Ornamental cherry trees look their best in early spring when they are in blossom.

ive only for as long as they remain in flower. For the rest of the year they are often fairly dull. They can also be expensive to look after, and so the trend in recent years has been towards planting native or naturalised trees that are cheap to maintain, yet have attractive foliage.

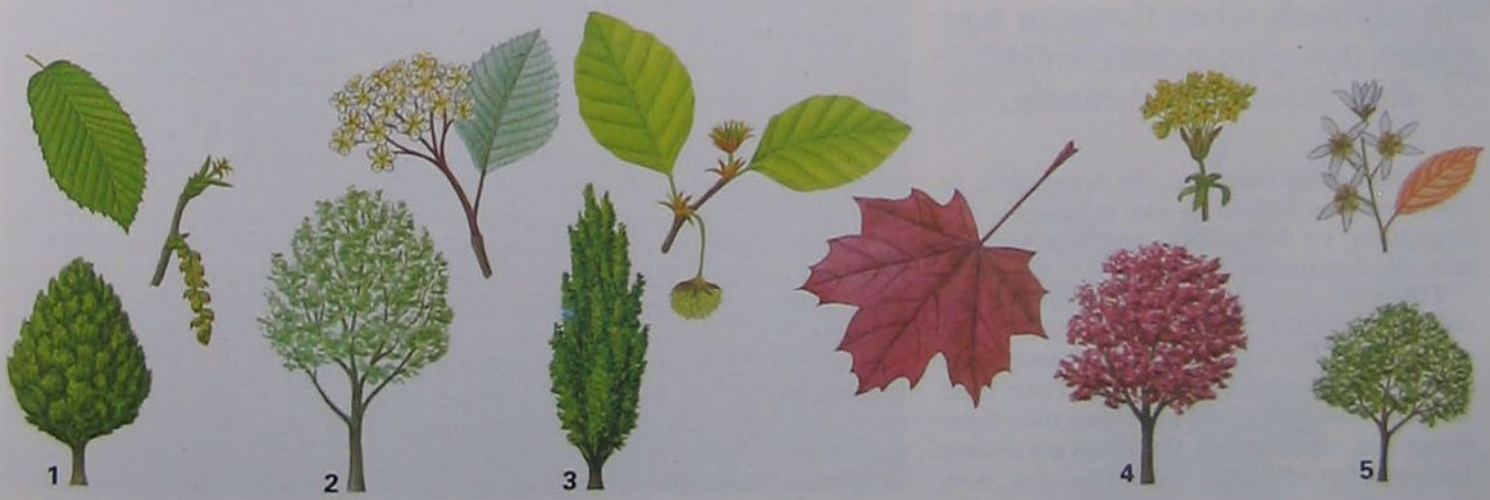
As local authorities have been forced to cut back on services, so cost has become an increasingly important factor. It is now essential that most trees being planted are quick to establish themselves, transplant easily and grow strongly during their first year.

The obvious choice is to plant suitable vartities of our own native trees, since they are usually self-reliant and easier to establish than trees native to other countries. Examples include a variety of hornbeam, *Carpinus betulus* 'Fastigiata,' and the Dawyck beech (*Fagus sylvatica* 'Fastigiata'), which are both upright forms whose leaves turn a beautiful golden colour in the autumn, and two types of hawthorn, *Crataegus monogyna* 'Stricta' and *Crataegus oxycantha* 'Coccinea Plena', the latter being a lovely domed tree often called Paul's Double Scarlet. Two beautiful flowering trees are Voss's laburnum (*Laburnum* × *watereri*) and the snowy mespil (*Amelanchier ovalis*).

Many of our most popular native street trees come from just two genera, *Acer* and *Sorbus*. Among the former, a variety of sycamore, *Acer pseudoplatanus* 'Brilliantissimum', with leaves that are first shrimp-pink and then turn pale bronze and finally green, and *Acer platanoides* 'Crimson King', with its purple-crimson leaves, are notable. The genus *Sorbus* includes some beautiful whitebeams, such as *Sorbus aria* 'Lutescens', and the rowan (*Sorbus aucuparia*).

It is good to see that our native trees are finally being given the recognition they so richly deserve. So often in the past, some brightly flowering foreign tree has been acclaimed without considering the beauty and practical advantages of our own species.

1 *Carpinus betulus* 'Fastigiata', an upright form of hornbeam.
2 *Sorbus aria* 'Lutescens', a variety of whitebeam.
3 *Fagus sylvatica* 'Fastigiata', Dawyck's beech.
4 *Acer platanoides* 'Crimson King', a variety of Norway maple with crimson leaves.
5 *Amelanchier ovalis*, the snowy mespil, an American tree now naturalised here.



DELICATE DAMSELFLIES

Damselflies – resembling small, vividly coloured dragonflies – are usually found on the wing in summer, when they can be seen flying by ponds, rivers, slow streams and canals.

The insect order Odonata, the dragonflies, is represented in Britain by two suborders, the Zygoptera, or damselflies, and the Anisoptera, the dragonflies themselves.

There are several basic differences which enable damselflies to be distinguished from dragonflies. The latter are large insects with stout bodies and powerful flight. Their hind wings are broader at the base than their forewings and, when at rest, the wings are always held out flat on either side. The eyes, seen from above, are nearly always close together or touching.

Damselflies are smaller insects with slender bodies and weak, fluttering flight. Their fore and hind wings are similar in shape and, when at rest, are generally held over the back, either together or slightly parted. Their eyes are more widely separated than those of dragonflies.

However, the two groups also have several features in common, including the fine, net-like veining of the wings; the large eyes and very small antennae; the predatory habits of both the aquatic nymphs (or larvae) and adult stages; and the distinctive method of mating.

There are 17 species of damselfly listed as British, but two of these have not been seen since the 1950s and are probably now extinct in Britain. Despite the relatively small number of species, damselflies are not at all easy to

Above: The male of the large damselfly, the banded agrion (*Agrion splendens*), is unmistakable, due to the broad, iridescent purple-brown or deep blue band on its wings. This appears near the tip of all four wings, the rest of the wing being only slightly tinted. The female (shown above left) is not banded and her wings have a rather brownish tinge. Damselflies rest in a position more akin to butterflies than to dragonflies, with their wings held together over their backs.

identify. Almost half the species have blue and black bodies, with very variable markings. Also, the full colour pattern does not develop until a few hours, or even days, after emergence, and the early stages of the damselfly are comparatively dull and pale.

Mating and reproduction The process of courtship and mating is very similar in dragonflies and damselflies, but differs from that of other insects. The genital opening of both sexes of damselfly is near the tip of the tail, but before mating the male transfers his sperm to an accessory genital organ on the underside of his abdomen, just behind the thorax. He then finds a female and seizes her by the back of the neck with a pair of claspers situated at the hind end of his body. They then fly about in tandem, and settle, linked together in this way. When mating takes place the female bends her body round under the male's body, and the sperm is transferred for fertilisation.

In some species, a form of courtship has been observed before mating. The male banded agrion, for example, signals to a passing female by bending his abdomen upwards and spreading his wings. If the female responds by landing near him he performs a fluttering, aerial dance over her before settling and taking up the tandem position.

Egg-laying The female damselfly lays her eggs under the water, inserting them in slits in the stems of plants which she cuts with a saw-like ovipositor at the tip of her abdomen. The male and female often remain in tandem during egg-laying, and sometimes both will walk down the stem of a plant until they are submerged to a depth of several inches. They may stay in this position for 10 or 15 minutes, a film of air clinging to the thorax of both damselflies and giving them a silvery appearance. When they emerge again they need only a few minutes to dry their wings before they are able to fly away.

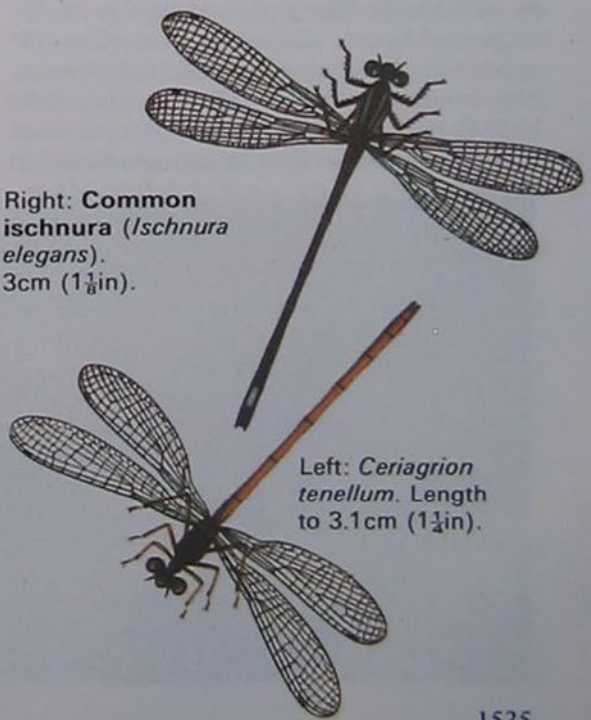
Above: The male demoiselle agrion (*Agrion virgo*) has rather spectacular colouring. The body is a dark, shining green and the wings are deep purple-brown to dark blue, becoming bluer with age. This newly emerged male has not yet developed the final deep coloration on its wings.

Below: The red-eyed male of the large red damselfly (*Pyrrhosoma nymphula*), eating a small fly. Damselflies feed on other insects, using their large, efficient eyes to find and pursue them. They may catch their prey on the wing, or take resting insects from reeds or herbage. In either case, the front legs, which are directed forwards, are used to capture and hold the victim.

The eggs hatch to produce larvae known as nymphs because of the absence of a pupal stage. The nymphs spend up to two years underwater, depending on the species, living at the bottom among the aquatic plants. They climb out of the water for their final moult, when the winged damselflies emerge.

Two large damselflies The demoiselle agrion and the banded agrion are our largest and most beautiful species of damselfly. The demoiselle agrion is found mainly in southern England, particularly in the New Forest and in Cornwall, and also in Ireland. The nymphs live in fast-running, clear streams with a pebble bottom. The metallic green body of the adult measures about 4.5cm (1¾in) long, and the male has dark, iridescent wings. The wings of the female are dull brown, with distinct dark veins, and a white spot appears near the tip of each wing.

The banded agrion occurs all over southern England and in Ireland, and may be abundant in favourable localities. The nymphs are found in fast-flowing streams with a sandy or muddy bottom. The adult's body is dark, metallic green and the male has distinctive bands across all four wings. The female is not



Right: **Common ischnura** (*Ischnura elegans*). 3cm (1⅛in).

Left: *Ceriagrion tenellum*. Length to 3.1cm (1¼in).

Above: A mating pair of the common coenagrion (*Coenagrion puella*). The female—the back of her neck held by the male's claspers—bends her body round, underneath that of the male. Her genital opening makes contact with the male's accessory organ and sperm is transferred to fertilise the eggs.

banded and resembles the female demoiselle agrion.

Five colourful species The large red damselfly first appears in mid-May, rather earlier than the other species. It breeds in lakes, canals and slow-moving, clean, fresh water and is one of our commonest species, being found all over the British Isles.

Both sexes have a red abdomen with black markings, a black thorax striped with red, and black legs. In a rare variety of the female, the thorax is striped with yellow and the abdomen is black with narrow yellow rings. The overall body length is about 3.6cm (under 1½in); the other red species, *Ceriagrion tenellum*, is smaller and has pale red legs.

The common coenagrion is found in England and Ireland (but not in Scotland) wherever there are clean ponds, ditches or canals with plenty of reeds and long grass. It is the commonest of several species in which the male is predominantly blue, marked with black. The male coenagrion is distinguished by a U-shaped black mark on the upper side of the second abdominal segment. The female is normally black, with a little blue at the tip of the body, but sometimes resembles the male. Both sexes measure about 3.3cm (1¼in).

The common ischnura is widespread in ponds and ditches and seems to be more tolerant of pollution than the other species. Both sexes are black, with a blue band near the end of the body which may be absent in the female.

The green lestes (*Lestes sponsa*) which is found throughout the British Isles, lives and breeds in open ditches, ponds and lakes fringed with rushes or reeds. Measuring 3.8cm (1½in) it has a metallic green body and clear wings.

Damselfly rarities Two less common species are easily recognised and worth looking out for; both are local in southern England. The white-legged damselfly (*Plactynemis pennipes*) is a pale coloured insect with white, feather-like hind legs. The red-eyed damselfly (*Erythromma najas*) is similar in coloration to the common ischnura, but is more robust in appearance and has bright red eyes. If you find one, photograph it, don't collect it.

Water pollution is the major threat to damselflies. A site in the Norfolk Broads, visited in 1975, was found to contain only one species—the common ischnura—whereas 30 years previously 16 species of damselflies and dragonflies were living there, including one species now extinct. Unless the pollution of such sites is controlled, then a further rapid reduction in numbers of these beautiful aquatic insects seems more than likely.

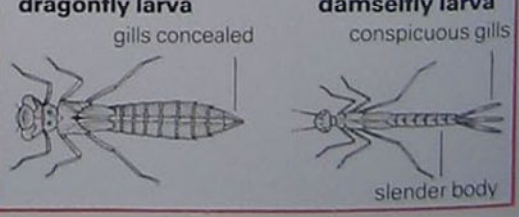
Below: The nymph of a damselfly does not pupate. After several moults, when it is almost mature, the nymph—like this one of the common coenagrion—climbs out of the water on to a reed, the skin splits open and the winged damselfly emerges. The full adult coloration takes a little while to develop after emergence.

Larval lifestyle

Damselfly larvae or nymphs differ from those of dragonflies in being more delicate and slender (like the adult insects). They also have three conspicuous, leaf-like gills at the hind end of the body, through which they breathe, whereas the gills of dragonfly nymphs are concealed internally. The larvae spend one to two years underwater, living at the bottom, among aquatic plants. They are highly carnivorous, feeding on a variety of small aquatic insects and crustaceans.

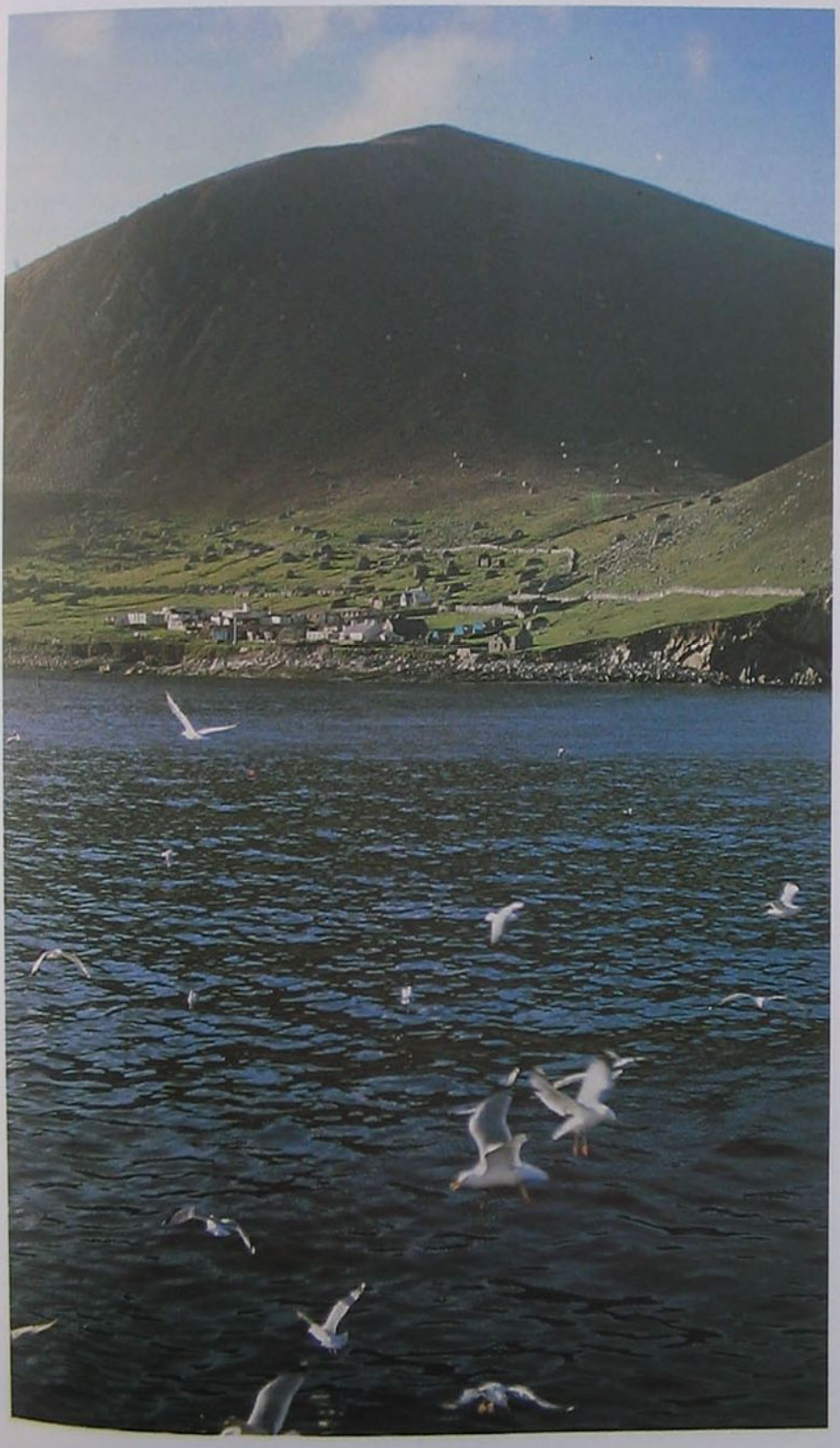
All Odonata larvae capture their prey by means of a greatly enlarged labium, or lower lip. This is jointed so that it can be extended forwards or withdrawn under the head, and it has a pair of grasping claws at its tip.

When suitable prey is spotted, it is stalked to within a few millimetres and the labium is shot out, then pulled back with the victim firmly in its grasp. The labium is not projected by direct muscle action, but by an increase in blood pressure following the contraction of muscles in the abdomen.



SURVIVAL ON ST KILDA'S ISLANDS

The rocky, treeless islands of St Kilda, the most remote outcrops of the British Isles after Rockall, were inhabited until 1930, but now they are deserted and have reverted once more to their original enduring community of plants and animals.



To zoologists, archaeologists and anyone keen on volcanic geology, St Kilda is unique among the outlying island groups of our western seaboard for its remoteness. It is separated from North Uist in the Outer Hebrides by some 72km (45 miles) of open Atlantic. Despite this, or more likely because of it, St Kilda has always attracted island-goers and can boast a saga of human occupation dating from the Viking invasion well over a thousand years ago. After the Norsemen came the Gaelic-speaking settlers from the Western Isles, their precarious livelihood having a profound influence on the natural history of the islands.

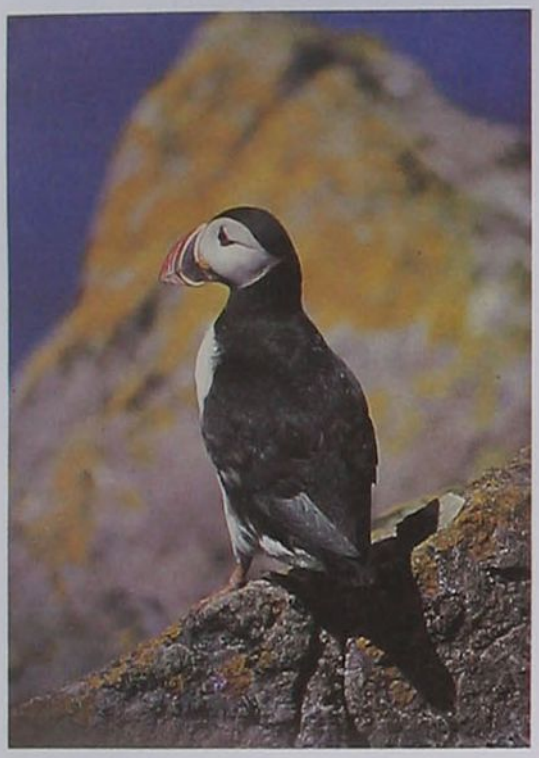
By the turn of the 19th century the community was in a sadly beleaguered state and, with its evacuation in 1930, the subsistence life on St Kilda came to an end. Today the only permanent human presence–an army radar detachment–is well-cushioned from the sort of hardships that beset earlier colonizers.

There are four main islands and several small stacks in the St Kilda group. By far the largest of the islands is Hirta at 638 hectares (1576 acres), followed by Soay and tiny Dun and, to the north-east, Boreray which covers a mere 77 hectares (190 acres). Anyone familiar with the western highlands of Scotland will find the vegetation of these islands fairly similar. Devoid of trees, the landscape is dominated by grassland swards, with smaller areas of heather and bog. There is a small area of derelict arable 'field' in the village area on Hirta, while the cliff-tops support a maritime flora modified by sea spray and the seabird community; here tussocky red fescue is dotted with white clover, plantains, buttercups and thrift.

Special sheep One of the strongest influences on St Kilda's vegetation has been its celebrated community of Soay sheep, the most primitive domestic form in Europe. Slight of stature, and pale honey to chocolate-brown in colour, the Soay resembles both the wild ancestral mouflon of Corsica and Sardinia and the domesticated neolithic sheep first introduced to Britain around 5000BC. Most likely, the Vikings established the type on the island of Soay, where it has persisted undiluted to this day.

Soay sheep played a vital role in the economy of the recent St Kildans. They confined the animals to Soay, visiting the island once or twice a year to round up the 200 or so animals. Goat-like, and highly adept at negotiating precipitous slopes, these wild Soays must have presented a formidable challenge to man and dog, and it is little wonder that the more manageable Blackface breed was kept on Hirta.

The soft, short Soay wool was not clipped but plucked by hand, then carded, spun and woven into tweed in the long winter nights. After the evacuation, Soays were introduced to Hirta where they have since been intensively



Above: The St Kilda wren, a distinct island race, benefits from insect food attracted by the sheep, and even more, perhaps, from those insects frequenting the bustling, guano-rich colonies of seabirds. The wrens especially favour the burrows of puffins (left) for foraging.

Previous page: Village Bay, Hirta, viewed from the sea, with some of the large population of gulls that haunt all four of St Kilda's main islands.

studied as a feral population of herbivores that fluctuates with the vicissitudes of climate and grazing.

Unique to St Kilda Also indigenous to St Kilda is the distinctive St Kildan field-mouse. It is strikingly large for a mouse, weighing twice as much as its mainland relative, and it has longer ears and a tail as long as its body. The whitish undersides of the mainland field-mouse are, in the St Kildan form, warm reddish-brown or orange-buff.

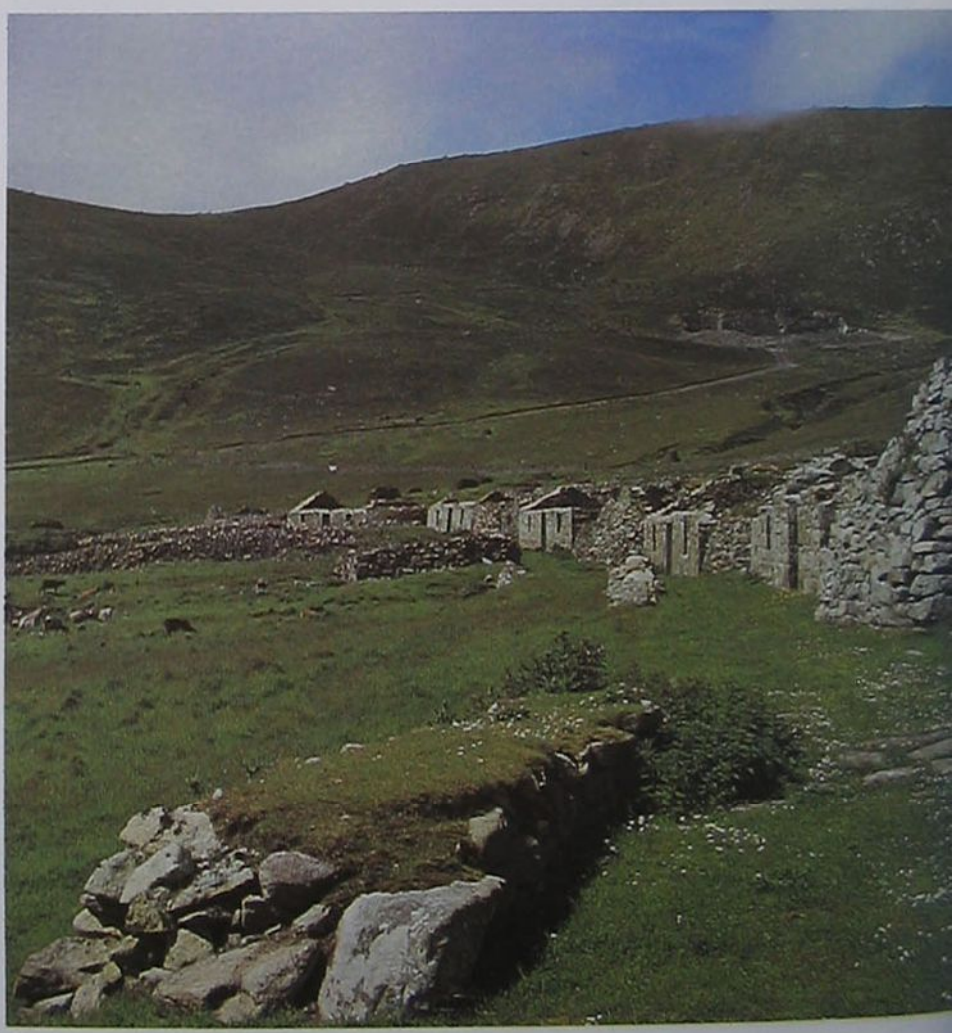
How the field-mouse arrived on St Kilda is something of a mystery, but one attractive hypothesis is that the Vikings accidentally introduced both it, and the now extinct house-mouse, with hay destined for the Soay sheep. House-mice cannot survive long in the absence of man, and dwindled with the community on whose homesteads they depended. The more versatile field-mouse was quick to prosper at the expense of the house-mouse in the ruins of the old village on Hirta where today it is numerous and remarkably tame.

St Kilda is also endowed with a distinct race of the wren, so different from the mainland bird as once to have been deemed a separate species. Like the sheep and mice, its origins are buried in antiquity, but it may have colonized St Kilda before the last Ice Age (when birch, hazel and alder graced the islands), survived the relatively mild glaciation there and gradually changed appearance over the millennia.

Compared with the mainland wren, the St Kilda bird is bigger and more chunky; it lacks the warm cinnamon colour tones and has a less colourful song to match. As in other wren-inhabited islands, such as Fair Isle and the Faeroes, the St Kilda wren thrives without trees. The rich legacy of dry-stone buildings in Village Bay, the scree slopes, and the craggy cliffs make good hunting and nesting grounds for the population, thought to number around 250 pairs. To hear the rattling song echoing from the recesses of some sea-girt buttress leaves one in no doubt that the bird is thoroughly adapted here.

Dry-stone cleits Of special significance to the welfare of sheep, field-mice and wrens alike are the so-called 'cleits'–structures unique and indispensable to the late St Kildan culture.

Cleits are oblong structures, mostly 3-4m (10-13ft) long and 1.5m (5ft) high, made of corbelled dry-stone walls with a roof of turf-covered stone slabs. They were built in their hundreds all over the islands as storehouses for anything perishable–crops, peat, fishing

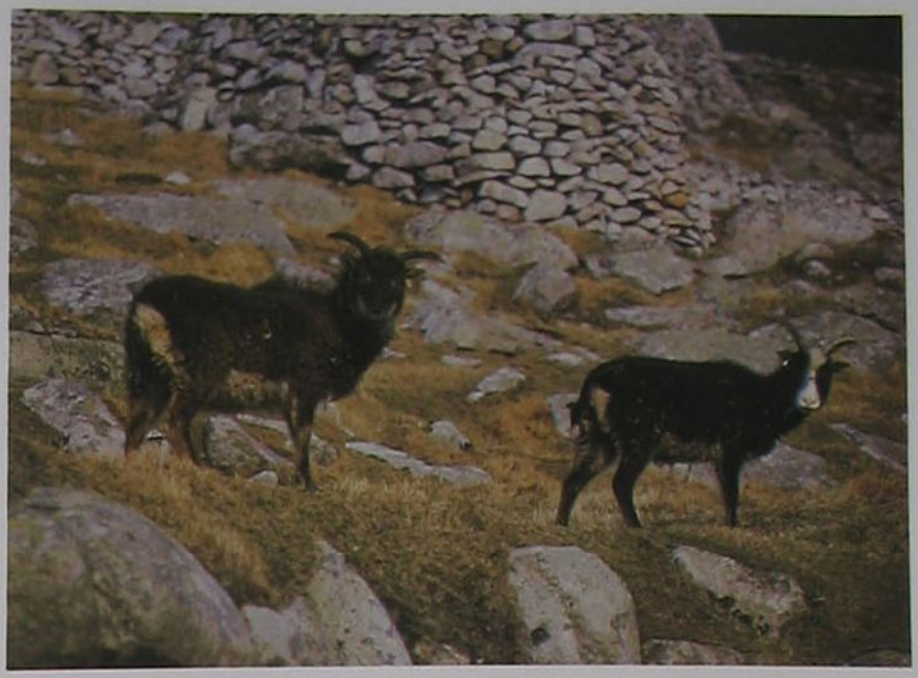


tackle, climbing gear and, above all, for the carcases of seabirds systematically harvested for food. Despite their unassuming architecture, cleits functioned admirably as meat-safes since the stone walls seemed to intercept much of the wind's moisture, keeping the interiors dry and cool.

While the greatest concentration of cleits survives in the village area, they are scattered all over St Kilda, in gulleys and saddles, at cliff-heads and indeed at virtually any level on the cliff face itself. As such, they are an invaluable refuge for wildlife. Sheep readily retreat inside them for shelter, and there are signs that many die peacefully within them. Cleits also serve as lambing chambers, while sheep scale the turf roofs to graze, often causing them to cave in. The dry-stone walls provide a wealth of nooks and crannies where field-mice and wrens can feed and nest, along with wheatears, starlings and even tree sparrows.

Various members of the 'tubenose' family of birds–storm petrels, Leach's petrels and Manx shearwaters–also avail themselves of the labyrinthine stonework for nesting, or join with the puffins in excavating burrows in the peaty floors.

Seabird colonies Of all St Kilda's wildlife, it is the seabirds which, by sheer weight of numbers, leave the most lasting impression. St Kilda is one of the major reservoirs of breeding seabirds in the north Atlantic, supporting upwards of half a million breeding pairs and 16 species.



Above: Soay sheep, ranging in colour from pale honey to chocolate-brown, used to be confined to the island of Soay. Now they live on Hirta as well and are studied as a feral population. After a 'crash' in population–in a year of harsh weather or poor grazing–the numbers of Soay sheep may plunge as low as 600 individuals. However, with the grazing pressure then relaxed, the survivors may multiply fast, sometimes triplefold.

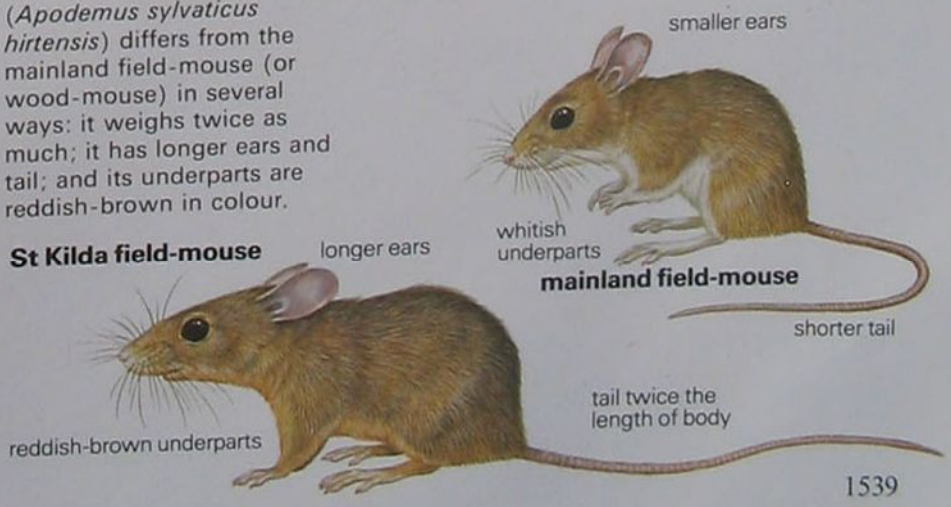
Opposite left: The village street on Hirta today, with the so-called 'Parliament Bench' in front. Today the deserted islands are owned by the National Trust and leased to the Nature Conservancy Council. The former inhabitants extracted a heavy toll of seabirds, using both flesh and feathers.

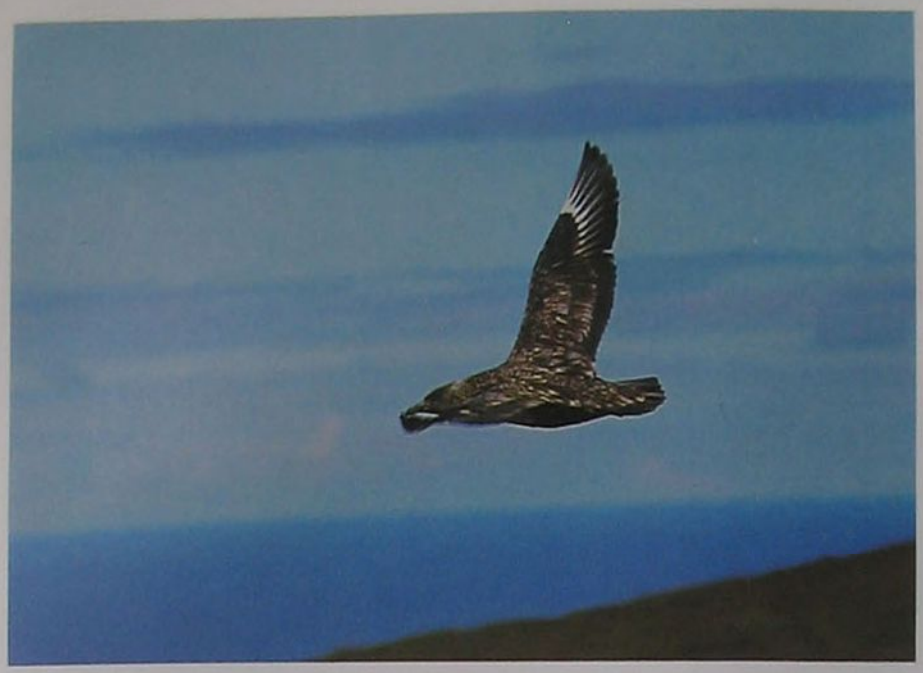
There are 60,000 pairs of gannets on Boreray and its stacks, accounting for about a quarter of the entire north Atlantic population. St Kilda's puffins (300,000 pairs) constitute about half the British total, fulmars (40,000 pairs) about 13%. Storm petrels are also extremely abundant, while Leach's petrel is less so, but their nocturnal, burrow-nesting habits make accurate counting impossible. There are also healthy populations of razorbills, guillemots and gulls, especially kittiwakes.

Some species, like the gannet and fulmar, may today be more numerous on St Kilda then they have ever been. In part this is because they are now immune from human predation. While the St Kildans in the last century were shrewd custodians of their seafowl, driving none to extinction, they nevertheless slaughtered vast numbers for food and feathers, the first often salted down for home consumption, the second traditionally exported to the mainland for stuffing mattresses.

One authority estimated an annual harvest of 12,000 young fulmars (from 20,000 hatch-

The St Kilda field-mouse (*Apodemus sylvaticus hirtensis*) differs from the mainland field-mouse (or wood-mouse) in several ways: it weighs twice as much; it has longer ears and tail; and its underparts are reddish-brown in colour.





Above: A great skua, often known as a bonxie on St Kilda, may well dive-bomb a human intruder, 'thumping' its feet down as it passes overhead—a painful experience, as many visitors to the islands testify.

Left: The caterpillars of the antler moth are a form of prey favoured on St Kilda by the lesser black-backed gull, which hunts for them on the grassy and heather-covered slopes.

ed) and 4000 gannets (2000 adults, 2000 young). In one year the toll of puffins was put at almost 90,000, while lesser numbers of other species were also taken. Guillemots were valued principally for their eggs which, like those of the other cliff-dwelling species, were only accessible with a rare blend of agility, skill and nerve—cultivated from an early age in the St Kildan children.

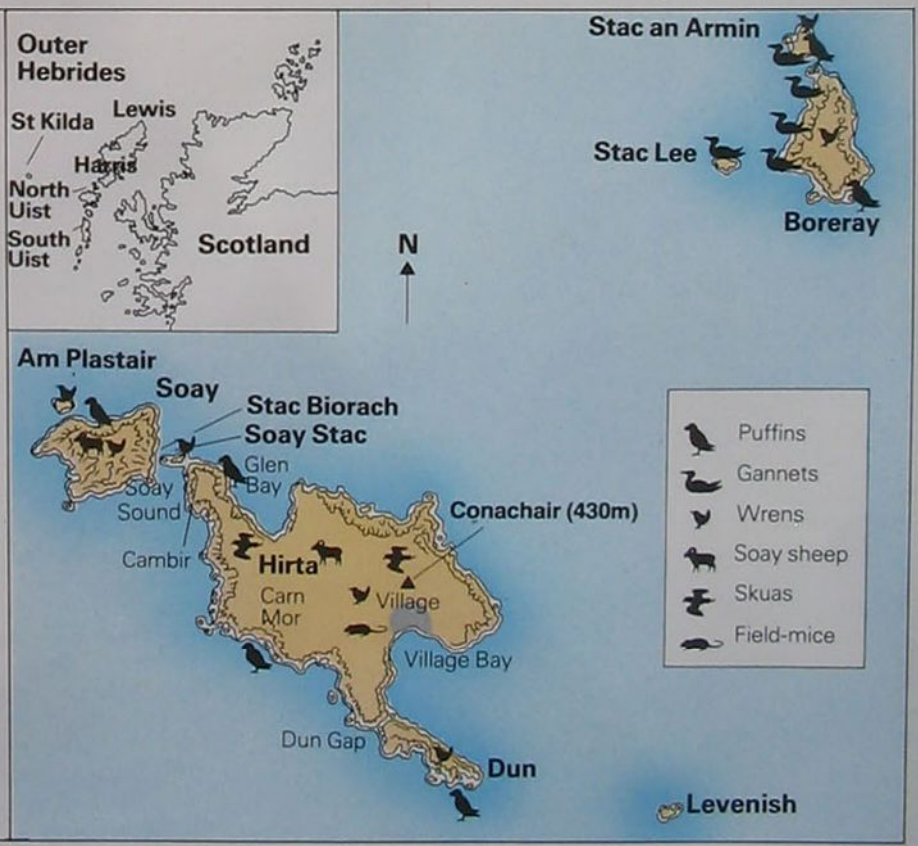
Predatory birds Today, the only significant predators are the birds themselves, and many show a flair to equal the daring exploits of the St Kildans. Great black-backed gulls quarter the puffin slopes remorselessly, waiting to pounce on hapless birds wheeling near their burrows. Most are caught in full flight by the neck and brought to the ground for dispatch. On Dun the gull population (40 pairs) feeds almost entirely on puffins in summer, taking about 2600 victims annually and inflicting heavy losses in some parts of the island.

The lesser black-backed gull is quite benign by comparison with its rapacious cousin, and can often be seen hunting quietly on foot for the caterpillars of antler moths on the grassy and heather slopes where many of the gulls breed. For the snipe and the occasional pair of whimbrel which nest nearby, the gulls must seem strange bedfellows.

Although the big predatory gulls confine most of their attention to the sea slopes, the hinterland is often patrolled by other hunters—ravens, hooded crows and, increasingly in recent years, by great skuas which relish almost any animal food, dead or alive. Since the skuas first bred on Hirta in 1963 their numbers have risen steadily to about 25 pairs. They take special exception to human trespassers on their breeding territory.

The wildlife of remote St Kilda

The St Kilda group is separated from North Uist in the Outer Hebrides by some 72km (45 miles) of open Atlantic. It is an archipelago of four islands and several stacks. The largest island, and the cradle of St Kildan culture, is **Hirta**, peppered with the stoneworks of the former settlement. Hirta also claims the group's highest point, Conachair, whose gentle conical summit (430m/1410ft), as seen from the village, disguises a sheer drop of over 330m (1000ft) to the Atlantic. Hirta is closely flanked by two islands—to the north the cliff-bound mass of **Soay**, to the south the snaggle-toothed **Dun**. Some 6km ($3\frac{3}{8}$ miles) north-east of Hirta lies **Boreray**, guarded by its two satellite pinnacles **Stac Lee** and **Stac an Armin**. Gannets nest only on Boreray and its two Stacs; puffins live mainly on Soay, Dun and the west coast of Hirta; Soay sheep are found only on Soay and Hirta; field-mice frequent the village area in particular on Hirta; wrens are widely distributed on the cliffs and slopes of all islands except **Levenish** and Stac Lee; and great skuas favour the inland heather areas on Hirta.



BLACKCAP AND GARDEN WARBLER

These two warblers nest in thickets and open woodland. It is hard to get a good enough view to tell which is which; if you succeed in coming close up to them, you may notice that one has a 'cap'–but the other has no distinctive markings at all!

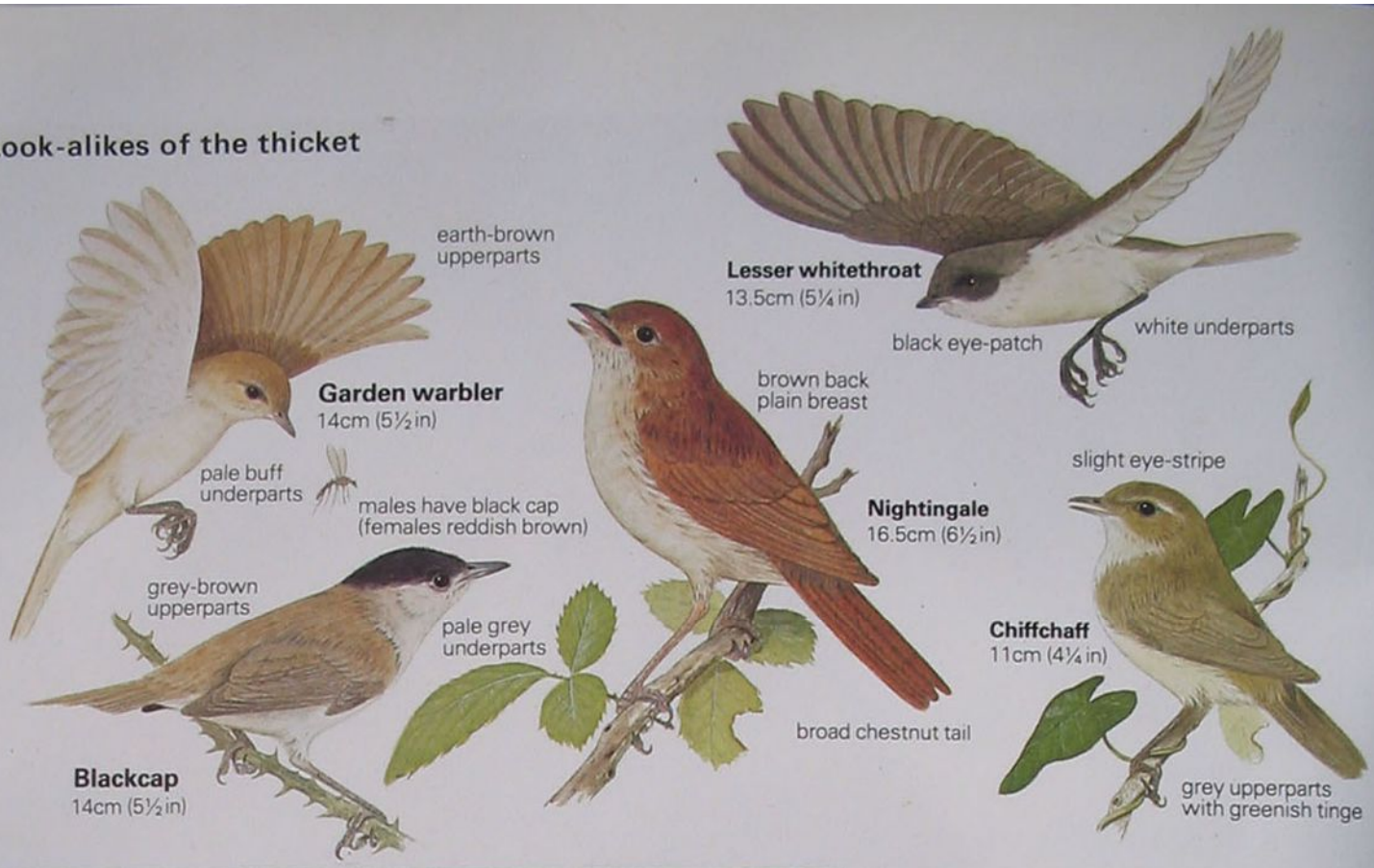
Above: A garden warbler tidies its nest. The nest is more substantial than that of the blackcap, but both species use similar materials: grasses and roots, often lined with a thin layer of mosses and hair.

Birdwatchers have a habit of referring irreverently to some groups of birds as 'little brown jobs'. On account of their rather drab plumage, the similarity between species, and the consequent difficulty in identifying them, many of the warblers fit nicely into this category of birds. In fact, the garden warbler is so featureless that it has been said that its best field character is its lack of distinguishing marks!

In addition to looking rather alike, warblers also have similar life-styles. All but one (the Dartford warbler) of the British warblers are summer visitors; they all eat insects, and most have fairly melodious songs. When we look closely at the biology of similar-looking and closely-related warblers however, we find that there are important ecological and behavioural differences between them. It is, in fact, these differences that enable such outwardly similar species to live in the same district without severely competing with one another.

The blackcap and garden warbler are two species that illustrate this point well. They are closely related, both being members of the genus *Sylvia*. They are both typical warblers, with fine bills, bristles round the base of the bill and fairly short, rounded wings; and both feed by gleaning insects from foliage and catching other insects in flight. They are about the same size, being 14cm (5½in) long and weighing around 20g (¾oz).

Look-alikes of the thicket



Above: The female blackcap does have a 'cap', but it is an attractive reddish-brown instead of black.

Right: A blackcap nest with eggs. The eggs of both species have white, yellowish or greenish backgrounds, blotched and spotted with brown or grey. Garden warbler eggs tend to be slightly larger and glossier, and often number only four compared to the blackcap's usual five.

Even their songs are so similar that most people are unable to distinguish them. The experienced ear, however, recognises that the rich warbling song of the blackcap consists of more varied notes than does the warbling of the garden warbler, and that the latter sings in longer phrases.

Hide and watch them Song is certainly not a good identification feature, however, and for most people the only way to decide between the two species is to obtain good views. Then, the birds are more readily distinguished.

The garden warbler is pale buff below and earth-brown above. It has no eye stripe or other head marking, or indeed any other patterning that can be regarded as a distinguishing feature. Fortunately for the bird-watcher, however, it is the only warbler in Britain and Ireland to lack such markings. The blackcap is a greyer bird, being grey-brown above and a paler ashy grey below, but its best field character is the colour of the forehead and crown. In the male, these parts are glossy black, while in the female this 'cap' is reddish-brown. Young males in the autumn can look slightly strange, with both black and brown feathers in the cap.

Once you have determined that the bird is either a blackcap or a garden warbler, some other slight differences between the two species become apparent. Although the songs are very similar, the two birds tend to sing in different places: the garden warbler sings low down in thick undergrowth, where the songster is well hidden, and the blackcap sings on favoured perches in bushes or tree-tops, although again usually hidden by the foliage.

Different habitats This difference in singing position may seem trivial but it is, of course, related to the habitats that the two species

Opposite: A garden warbler feeds its young. These fledge when about ten days old. This rapid growth is very important for their survival, keeping to a minimum their time of greatest danger, for nests low down in the bushes are well within the reach of foxes, weasels and other denizens of the thicket. Each year, about half of the nests of both blackcaps and garden warblers are plundered by these predators, which find it easier to locate a nest containing calling chicks than one on which an adult bird is silently incubating. The shorter the time the chicks remain in the nest, the greater their chances of survival.

Above: A garden warbler surveys its territory. This is the only bird in our countryside to have such an utterly bland appearance: indeed, the absence of any stripes, contrasting colours or white marks is the best way to recognise the species.

Garden warbler (*Sylvia borin*); summer visitor; warbler typical of thickets and large gardens; sings from low down in bushes. Length 14cm (5½in).

Blackcap (*Sylvia atricapilla*); mainly summer visitor, with small numbers overwintering; warbler nesting in thickets with tall trees; sings from tree-tops or bushes. Length 14cm (5½in).

prefer. Again, there are close similarities, and blackcaps can be found breeding alongside garden warblers. Both species inhabit open woodland and copses with thick undergrowth, often of brambles, in which the birds nest. Large gardens, too, may play host to one or both of the warblers. But while garden warblers often nest in thickets where there are no trees, blackcaps seem to require that tall trees should be a feature of the habitat. Blackcaps are also more likely to nest in areas of evergreens than are garden warblers.

Both species build their nests in dense thickets, especially of brambles, but once again slight differences occur in the actual positioning of the nest. Once you know the bird must be either of these two species, the height can often be a helpful guide. Nests between 30 and 60cm (1 and 2ft) above the ground could belong to either species; but a nest below 30cm (1ft) is likely to belong to a garden warbler, and one above 60cm (2ft) is probably that of a blackcap.

Blackcaps arrive first The general lifestyles of the blackcap and garden warbler are therefore very similar, although differences in song, habitat and nest position can be noted. These may appear minor to us, but they are undoubtedly very real to the birds. Much greater differences, however, become apparent between the two species when we look at the timing of events in their life cycles.

Blackcaps make their presence felt by singing from March onwards. Those that sing in early March are probably birds that have spent the winter in Britain – for although the species is overwhelmingly a summer visiting one, small numbers do stay for the winter in Britain and Ireland. In late March, the returning migrants begin to swell the numbers; this arrival continues during April. Males arrive first, and quickly establish territories and start to sing, so that when the females arrive a week or two later, pairing can occur without delay. Nest-building and egg-laying take place in late April and early May. This early breeding, and the rapid development of the young, enable some pairs of blackcaps to rear two broods each year.

Male garden warblers arrive a week or so in advance of the females and similarly devote their time to establishing territories and singing. Garden warblers, however, do not begin to appear until late April, and their arrival continues through May. They are consequently unable to breed as early as blackcaps, and the peak of nest-building and egg-laying for garden warblers does not occur until the middle of May.

Migration patterns Why should there be this difference in the time of arrival, and hence of breeding? For the answer to this question we have to look beyond our shores. The garden warbler has a far longer migration: its wintering grounds range from tropical western Africa (Guinea and Nigeria) to Kenya, and from there to southern Africa. Blackcaps, too, travel to Africa, but their wintering range generally lies north of that of the garden warbler. Some blackcaps winter around the Mediterranean, and a few even stay in southern England. This species therefore travels a much shorter distance on its migration and this, together with its greater ability to utilise winter foods such as the berries of holly, privet and ivy, means that it can undertake its relatively brief and rapid migration early, permitting an early spring arrival in the breeding area.

Not only do garden warblers arrive later, but they must also depart earlier for their autumn journey to Africa, and they make their preparations for this (by feeding to store fat) well in advance of blackcaps; and so the featureless warbler of our scrubby woodlands has a hectic summer season. Could it be that this hectic life and all the dangers of the long journeys contribute to its scarcity, compared with its close relative? Blackcaps are three times as abundant in Britain.

GRASS FOR GRAZING

Grassland – such a dominant feature of the landscape in this country – is not natural, but man-made and our most familiar species of grass are planted with a purpose.

Above: Cocksfoot (*Dactylis glomerata*) is common in meadows and on roadsides, as well as being cultivated in pastures. Fodder grasses like cocksfoot are wild species cultivated for their grazing value, and to provide food for as much of the year as possible. A coarse, tough grass, it has rough-edged leaves with a strong keel or ridge down the centre. It is in flower (see below) from June to September.

Grasslands in the British Isles are entirely man-made and have been developed over the centuries to suit the needs of our domesticated cattle and sheep. Given a sufficiently long period of non-interference much of our pastureland, meadows and downland will degenerate from grassland to scrub, and return ultimately to forest.

Natural grasslands, such as the steppes of Central Asia, the veldt of South Africa and the prairies of North America, are characterised by the enormous variety of species of both grasses and herbaceous plants that grow there. In contrast, only a small number of grass species are at all important in this country. There is, however, a bewildering array of selected strains, developed from these wild species, which are available to the farmer. He can choose the most suitable for his particular need, be it hay, silage or permanent pasture.

Two categories of grassland are recognised. The first of these is called 'rough grazing' and is found on open hillsides overlying chalk and limestone in the south and east, and siliceous rocks in the north and west. Lowland commons also fall into this category.

The second type is called 'permanent grass' and is usually enclosed, and often manured, growing on a variety of soils. Much of it began as arable land but was laid down to grass (that is, deliberately sown with grass seed) when arable crops ceased to be profitable. On the whole, the grasses sown were native species and only one foreign species, Italian rye-grass, is at all common.

Abundant rye-grasses An easily-recognised species which is abundant not only in pastures but also on our lawns, is perennial rye-grass. It can be confused with couch grass, a rapacious weed which has a similar appearance and is very difficult to eradicate when it takes hold on farmland.

Perennial rye-grass has been cultivated in this country for over three hundred years and is considered our most valuable species. It is a quick-growing, heavy-yielding grass and is highly nutritious. It is often sown with clovers for leys (short-term grassland) and permanent pasture, and is suitable for most types of soil. During its long history of cultivation a number of strains have been developed. Some are suitable for hay, others for pasture; some are short-lived and stemmy, others are long-lived and leafy. The best kinds come from our own native varieties.

Italian rye-grass is a close relative of perennial rye-grass. It is an annual, or sometimes a biennial, and can be distinguished by the extra florets appearing in each spikelet, and the bristles (or awns) that protrude from the tip of each lemma (the outer pair of scales enclosing each diminutive flower). Introduced into the British Isles in 1830, it is now widely sown for short-period leys of about one to two years. It grows very quickly from

Examining a grass flower head

The flower head of cocksfoot (right) consists of a number of short branches, each with a cluster of short-stalked spikelets. (The spikelet is an individual unit of the grass flower head, usually made up of two glumes, or bracts, and the florets.) The spikelets of cocksfoot can be green or purplish, with two to five florets. At the start of each season, cocksfoot has two types of stems: tall, cylindrical ones that will bear flowers in summer; and shorter, leafy ones that will flower the following year. The latter are flattened from the side and the sheaths bearing the leaves are V-shaped in cross-section.

1. Italian rye-grass (*Lolium multiflorum*). Flowers June-Aug. Ht to 1m (39in).

2. Timothy (*Phleum pratense*). Flowers June-Sept. Ht to 1.5m (59in).

3. Meadow fescue (*Festuca pratensis*). Flowers June-Aug. Ht to 1.2m (47in).

4. Tall fescue (*Festuca arundinacea*). Flowers June-Aug. Ht to 2m (78in).

5. Yorkshire fog (*Holcus lanatus*). Flowers May-Aug. Ht to 1m (39in).

Opposite: Perennial rye-grass (*Lolium perenne*) can be recognised by its long flowering spike, with stalkless spikelets growing edge-on to the stem on alternate sides. If you look closely at an individual spikelet, prising it gently away from the stem, you will see that it has only one glume instead of two. All other common British grasses have two glumes.

seed and is extremely nutritious, giving a heavy yield of palatable herbage. It is either grazed, or cut for hay or silage.

Drought-resistant grass Cocksfoot or orchard grass is a coarse, tough grass valued by farmers both for grazing and making into hay. One advantage that this species has over many of our other important grasses is that it takes root very deeply and can thus resist drought. As long as it is well managed it provides good herbage over a very long period, but it becomes coarse and unpalatable if under-grazed and is easily damaged if over-grazed. A variegated form is often grown in gardens.

Grasses of rich soils Two forms of timothy grass are found in this country–a tall variety, known as timothy or cat's-tail, and a shorter, leafy variety, known as purple cat's-tail. Both have tight, cylindrical flowering heads; timothy is used for hay, while purple cat's tail is normally grazed.

Until the mid-eighteenth century, timothy was a grass of water-meadows and low-lying grassland. An enterprising American agriculturist named Timothy Hanson discovered that it had enormous potential as a fodder grass and it quickly became a major source of hay in many temperate countries, being named timothy in Hanson's honour. Unfortunately, it does not grow aggressively and when a field of timothy is given over to pasture instead of hay, it gradually disappears in the face of competition from more vigorous grasses.

Purple cat's-tail is more hardy and is an important constituent of older pastures and short grass on hills and downs.

Meadow fescue is abundant in water-meadows, low-lying grassland, pastures and roadsides, especially on rich, moist soils. It is a tall, tufted perennial with a much-branched flower head and can form quite large tussocks. Although it can produce large quantities of palatable herbage, it soon dies out if too heavily grazed.

Tall fescue is a close relative of meadow fescue and the two are not always easy to distinguish. Tall fescue–as you might expect from its name–is a tall, tussocky species that grows in much the same type of habitat as meadow fescue.

Weed or fodder? Yorkshire fog is sometimes called meadow soft-grass or velvet-grass, two names which aptly describe its appearance. The stems form loose or dense tufts and are covered with short, soft, velvety hairs. The leaves are greyish green and rather dull, but they contrast well with the flowering heads which may be whitish, pale green, pink or purple.

As Yorkshire fog grows in all kinds of soils from heavy loams to sand in meadows, open woods and waste ground it is generally regarded as a weed. However, in some parts of the country where the poorer soils do not support the more desirable grasses too well, its young growth makes very good grazing.

In North Country dialect, the word 'fog' has nothing to do with winter mists but means any coarse winter grass that grows once the hay has been cut. It probably comes from the Old Norse word 'fogg', meaning a long, limp, damp grass.

WEASEL: SMALL BUT FIERCE CARNIVORE

Although weasels have long been persecuted, they are common today throughout the British Isles. Their fierce, relentless hunting techniques make them deadly enemies of the small rodents that form the bulk of their diet and, since they are strong and bold, they may also take prey larger than themselves.

WEASEL (*Mustela nivalis*)
Size Highly variable. Head and body 17-22cm (6½-8½in) plus tail 4-7.5cm (1½-3in). Adult weight 90-170g (3-6oz). Males are larger and heavier than females.
Colour Chestnut brown above, white below—similar to stoat but lacking the even margin between the brown back and white underside.
Breeding season from March to September.
Gestation period 6 weeks.
No of young 2 litters of 3-8 young per year.
Lifespan 3-4 years in the wild, up to 10 years in captivity.
Food Carnivorous. Mice, voles, rats, moles, shrews, rabbits, birds, frogs, toads, insects, reptiles.
Predators Man—trapping. Larger mammals, hawks.
Distribution All over mainland Britain.

The weasel is one of Britain's fiercest carnivores. It is sometimes confused with a relative in the mustelid family, the stoat, but it is generally smaller, although a male weasel and female stoat are about equal in size. Both species are similar in coloration, with chestnut-brown backs and white fur on the underside; but whereas stoats have a distinct dividing line between the two colours of the coat, weasels have an uneven margin which is different in every individual. Like that of the stoat, the tail of a weasel is short and bushy and the same colour as the back, but it lacks the stoat's black tip.

Weasels have long, slender bodies and short limbs, ideal for squeezing down mouse holes and mole runs, and into crevices in walls, to search for prey. The head is small and bluntly pointed, with small rounded ears. Weasels are found throughout mainland Britain, and on Anglesey, Skye and the Isle of Wight. They are not found in Ireland, but stoats are, and are known as 'weasels' in that country because they are smaller than the stoats found in mainland Britain.

Persecution Like all carnivores, weasels have long been persecuted by man, and they are still regarded as vermin by gamekeepers. Certainly they will take the eggs and young of game birds, and they raid chicken runs, but studies have shown that the value of weasels to farmers and foresters far outweighs these occasional depredations. During a year a family of weasels may account for 2000 or more destructive small rodents, especially mice and voles.

When rabbits were trapped on a commercial scale, weasels and stoats were often incidentally caught in gin traps and, during the 1950s, the populations of both mustelids declined. Today they are more abundant, and, when trapping does take place, more humane traps are used. Experienced trappers take advantage of the weasel's habit of hunting along natural boundary lines, such as walls and hedges, and set their traps in the cracks and crevices the animals like to explore.

Quick hunters Weasels are quick-moving, agile, relentless hunters. They patrol their territory at regular intervals, mostly at night but often during the day as well, running with their bodies held low or bounding along with their backs arched. Mice and voles are often pursued down into their underground runs. Occasionally weasels run along the tops of walls or hedges in search of birds and their nests. They hunt mainly by scent, stopping from time to time to stand on their hind legs to test the air and survey their surroundings.

Prey is killed quickly, with a bite to the back of the head. Animals such as rabbits and large birds are subdued by repeated attacks to the throat and major blood vessels. Weasels eat almost any animal that they can overcome and kill, from small rodents to shrews, frogs, birds and their eggs and even fish. They swim after water voles, and

Below: Scientists have found that, on average, male weasels eat 27% and females 30% of their body weight every day. They kill their prey by a sharp bite on the back of the neck.

nest is made of dry leaves, grass or moss in a hole low in a hollow tree
young weasels stay with their mother for 9–12 weeks
litter sizes range from 3 to 8, but 5 is the norm

Above: A weasel's nest. The female has two litters a year –one in April or May and the other in September. You'll find weasels in many habitats, ranging from woodland, farmland, hedgerows and moorland to mountains and even urban areas.

Below: Weasels are inquisitive animals, relying largely on scent to help them in their hunting. They are not very vocal. When they are alarmed they hiss and, if provoked, will give a short screaming bark. In captivity they remain very aggressive and will hiss, bark and snap at the slightest provocation.

occasionally take carrion. Excess food is sometimes stored in or near their underground dens. Dens containing the remains of up to 50 small rodents have been discovered.

Competition-free diet Weasels and stoats, with such a diversity of sizes ranging from the tiny female weasel at 23cm (9in) to the 40cm (16in) long male stoat, are thought by some ecologists to exhibit the phenomenon of 'character displacement'. They are all carnivores and therefore potential competitors, but, since they are in three size groups, they can often divide up the available food resources and thus avoid too much competition. At the two extremes of the range, the female weasel and male stoat are specialist predators on small rodents and large prey respectively. The female weasel feeds almost exclusively on mice and voles, while the male stoat is capable of killing prey up to the size of a large rabbit. The male weasel and female stoat, of roughly equal size, fall between these two categories and feed mainly on medium-sized prey animals.

The weasel population fluctuates with the abundance of food, particularly mice and voles. A weasel may live in a locality until almost all the rodents in an area of 180-275m (600-900ft) across are eliminated, before moving to a new home.

Separate territories Weasels are found in almost any habitat that has sufficient food and shelter. They are, of course, most common where the greatest concentrations of mice and voles are found. They also live in and around farm buildings, in park land or among stones and rubble on derelict land.

Males and females have separate territories, varying in size according to the abundance of prey. Males usually have larger territories than females and mark them with scent from musk glands beneath the tail. This scent is also released when an animal is frightened or disturbed and, as with most members of the Mustelidae, it is very pungent.

Weasels do not make regular runways within their territories, but they often use the runs and burrows of small rodents for their own shelter or den, and may sleep off a heavy meal in the home of a recent victim.

Two litters In Britain the weasel usually has two breeding seasons a year. The first begins in March and the young are born in April and May. The second may involve males and females born during the spring season, and continues until September. The seasons begin when males leave their territories to find a female in oestrus. It is thought that the musk glands may be used to attract males and

Weasel lore

For centuries the weasel has been attributed with magical properties. A 12th century bestiary says that weasel mothers can bring their dead young to life; weasels were said to drink the blood of their victims, a belief that probably arose from their habit of killing by a sharp bite on the neck and gripping tightly until the prey dies. They are also supposed to hypnotize their prey by 'dancing' before it. Their playful habits elicit mobbing behaviour from small birds, some of which come too close and become victims. It is unlikely that 'dancing' is a hunting technique used by many weasels, but a few may learn that it attracts prey.

females to each other. Unlike some mustelids, including the stoat, weasels do not show the phenomenon of delayed implantation, and the young are born six weeks after mating. The female nurses the young for four or five weeks, and if she is disturbed during this time will move them to a new nest site. The male weasel plays no part in rearing the young.

Family groups After weaning the mother continues her parental care by teaching her offspring to hunt and kill. Their education begins when the female brings back injured and disabled prey to the nest, but within a short time she takes them on hunting excursions throughout her territory.

The young remain with their mother for up to three months, by which time they can fend for themselves and their mother is involved with raising another litter. At this stage in their lives the young are at their most vulnerable and in looking for territories of their own many fall vicitim to traps or natural enemies such as owls, hawks and domestic cats. Their inquisitive natures can often prove fatal: their habit of bolting into a crevice when disturbed, to emerge after a few moments to investigate the cause of the disturbance, can have fatal results when the intruder is a gamekeeper with a gun.

Young from the second litter often stay with their mother for longer than three months and the family may not break up until the start of the breeding season the following year. Such family groups share the same territory, but may not necessarily keep together when foraging, and individual weasels may be scattered over a wide area. Occasionally, especially in winter, several family groups combine to form a pack of as many as 30 individuals.

Weasel parasites A number of parasites are found on weasels, and also fleas, which are commonly transmitted from their rodent prey. There is also a biting louse, *Trichodectes mustelae*, that is found only on weasels. The nematode worm *Skrjabingylus nasicola* is found in weasels' nasal passages and damages the bones and skull. although apparently causes no distress nor results in death.

Above: When moving, weasels look snake-like, and it was once thought that a weasel could squeeze through a wedding ring without difficulty. Such an event is unlikely, but it is true that the skull of a female weasel can be passed through a standard ring 2cm ($\frac{3}{4}$in) in diameter.

Below: A young weasel. Mortality during the first year is high and few weasels survive to the maximum expected lifespan of four years in the wild.

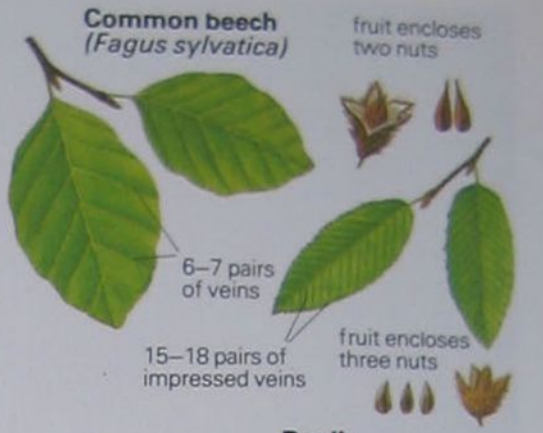
SOUTHERN BEECHES WITH A FUTURE

The southern hemisphere's equivalent to our own beech trees, southern beeches are just as beautiful and they grow much faster. Tests being carried out show that they may yet become commercially our most important group of broad-leaved trees.

Above: A stand of raulis at Benmore arboretum, Strathclyde. Some of the tallest raulis in the country are to be found here, one or two reaching as high as 25m (80ft). Raulis grow best in the damp western half of Britain. In the right conditions, it is one of our fastest-growing trees, some specimens reaching 15m (50ft) in under ten years.

The southern beeches are native exclusively to the southern hemisphere, just as our own beeches are confined to the northern. They are found in Australia, New Zealand, Papua New Guinea, New Caledonia and South America, but all of the most common species now growing in Britain come from South America, except for *Nothofagus gunnii* which comes from Tasmania.

In appearance, the southern beeches are similar to beech trees–indeed the scientific name for southern beeches, *Nothofagus*,



means false beech or resembling the beech. The fruits, in particular, are very much alike, in both cases consisting of a number of nuts enclosed in a two, three or four-lobed fruit called a cupule. The number of nuts inside the fruit varies from one to as many as seven, depending on species.

Of the 37 species of southern beech that are currently recognised, only ten are deciduous–all but one of these coming from Chile. All the rest are evergreens.

This group of Chilean deciduous species includes some that are potentially of great importance to British forestry. They are all being investigated by the Forestry Commission to establish which species are commercially the most suitable in Britain, what conditions they require, and which parts of their native ranges produce the best specimens. So far, results show that two species in particular, the rauli and the roble beech, could have a great future in this country as sources of timber and could possibly become our most important commercial broad-leaved trees.

Quick-growing rauli The rauli was introduced to Britain as recently as 1910 and soon proved to be an extremely quick-growing tree here. On a suitable site it is capable of growing to a height of 15m (50ft) in less than ten years. It is best suited to the western half of Britain, because it requires a fairly high degree of moisture.

In Britain, it forms a handsome tree growing to about 30m (100ft) high, with a broadly conical crown formed by the lower branches being level and the higher ones being swept upwards. The bark on young trees is grey-green and marked with lenticels; on older trees it becomes duller and develops long, broad vertical fissures.

The leaves of a rauli are similar to hornbeam leaves. They are oval, with a downy under-surface and finely toothed margins. Their most striking feature is the pairs of impressed veins, which give the leaves the appearance of being corrugated. Rauli leaves can be between 5cm (2in) and 10cm (4in) long. They are usually yellow-green–though occasionally dark green–and turn pale or deep

Roble beech
(Nothofagus obliqua)

Coigue
(Nothofagus dombeyi)

Antarctic beech
(Nothofagus antarctica)

Above: The southern beeches are best distinguished from each other, and from the common beech, by their leaves. All bear similar fruits, except that some southern beeches contain three nuts rather than two.

gold in the autumn.

The male flowers form inconspicuous solitary tufts of green stamens; the female flowers are even smaller and borne in the leaf axils. The fruits are deep green at first, ripening to brown by mid-summer. The mature fruits are about 1cm (⅜in) long and consist of a soft, feathery, 4-lobed cupule containing three pale brown nuts, each about 7mm (¼in) long.

In its native areas – the central parts of Chile and Argentina – the rauli forms large forests, though these are rapidly being cut down for the valuable timber. Rauli is one of the most important sources of timber in Chile and Argentina, and is used for doors, stairs, floors and furniture. It has similar properties to beech timber, being easy to season and fairly dense.

Roble beech The word 'rauli' is Spanish for beech; 'roble', however, is Spanish for oak, since the shape of this reminded early Spanish explorers of their own oaks. The roble beech comes from central Chile, where it occurs along the coastal ranges and up into the Andes. Extensive stands are also found in western Argentina, where it is more common than the rauli.

The roble beech was introduced to Britain in 1902 and has considerable potential as a source of timber in this country. It is not quite as fast-growing as the rauli, but it is better suited to drier, poorer sites and is also somewhat hardier than the rauli. In the drier eastern half of Britain, the roble beech can be found growing as far north as Aberdeen.

The roble beech grows to a height of 25-30m (80-100ft), and has a narrow conical crown (broadening on old trees) with characteristic arching branches. The smaller branches spread out and down in slender sprays.

The leaf is oval with a blunt tip; the leaf-base is rounded or wedge-shaped and unequal where it joins the stalk – hence its Latin name, *N. obliqua*. The leaf margins are irregular with small triangular teeth or small lobes, the latter occurring particularly in the lower part of the leaf. The upper surface of the leaf is deep green with seven to eleven pairs of impressed veins that give it a slightly waved appearance, while the underside is much paler and usually hairless. The length varies from 4cm (1½in) to 8cm (3in), and the autumn colour is usually yellow.

An unusual feature of the roble beech, shared with another South American species, the Antarctic beech, is the way in which the leaves are arranged in a herringbone pattern down both sides of the shoot.

Less familiar species Several other species of southern beech grow in Britain, though on a much smaller scale than the rauli or roble.

The Antarctic beech was the first southern beech to be introduced to this country, in 1830. It comes from the more southerly parts of Patagonia, and is a hardy deciduous tree growing to about 15m (50ft) high. The margins of the leaves have four rounded teeth.

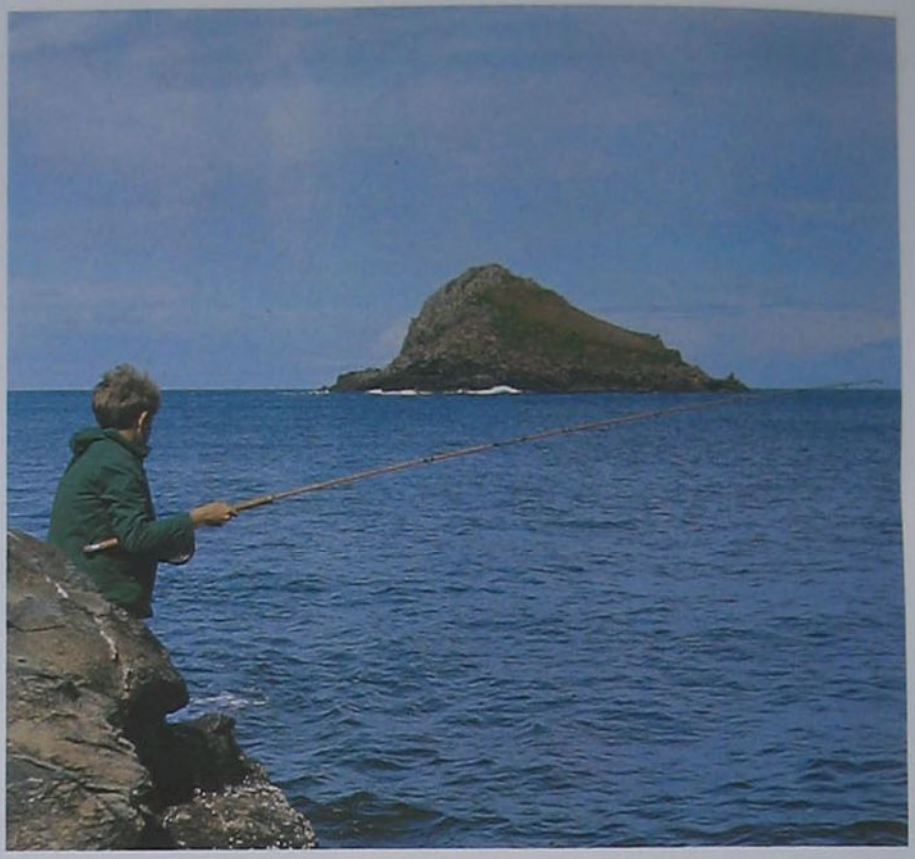
Another species of southern beech, the coigue, is one of the few evergreen species to grow here. Its leaves are dark glossy green above and paler matt green beneath; from a distance they appear blackish. Both leaf surfaces are studded with small black glands, best seen with a hand lens.

Above: The leaves and shoots of the Antarctic beech form a striking herringbone pattern, a characteristic shared by only one other southern beech, the roble beech.
An unusual feature of the leaf is that the veins end not at the tips of the teeth, as is almost universally the case, but at the gaps (called sinuses) between the teeth.

Right: The bark of a roble beech is pale grey, becoming browner and cracking into small plates with age. This species has great forestry potential in this country, particularly in the drier eastern half of Britain, where it is almost as fast-growing as the rauli.

A SPORTING FISH UNDER THREAT

Despite being a relatively scarce fish in British waters, the bass is a much sought-after catch among Britain's growing army of sea-anglers.



Above: Sea-angling has become increasingly popular in recent years, and bass is the ideal sport-fish, since it is often found in readily accessible inshore waters and it grows to a good size. The largest bass caught in British waters weighed 8.3kg (18lb 6oz) and was taken off the Eddystone Rock in 1975.

The bass is Britain's leading saltwater sport-fish and a large and growing number of anglers rely on it to provide their weekend and holiday sport. Yet it is highly vulnerable to over-exploitation because it takes a long time to reach maturity and, being at the northern limit of its range, it grows slowly in British waters. As sea-angling has increased in popularity, so the population of British bass has come under increasing pressure. Thirty years ago, fewer than 10,000 anglers fished regularly for bass; today the figure is well above 250,000.

More recently, the pressure has been magnified by growing commercial interests as bass has suddenly become a fashionable item on the menus of top restuarants. As a consequence, the market value of bass has increased tenfold during the last decade, and it can now command a higher price than salmon.

In the past, professional researchers paid little attention to bass because it was commercially unimportant. As a result, much of what is known stems from a handful of amateur investigators, mostly anglers with an interest in the natural history of their quarry and a concern for its conservation. Professional workers have now become more involved in this species, but there is much that remains to be learned.

Below: A young bass, seen here with smaller common gobies. Bass spend their first few years in creeks or estuaries.

Appearance and distribution The bass has a greenish-grey back, with silvery sides and belly, and a dark patch over its gill covers. It has two dorsal fins, the front one being spiny.

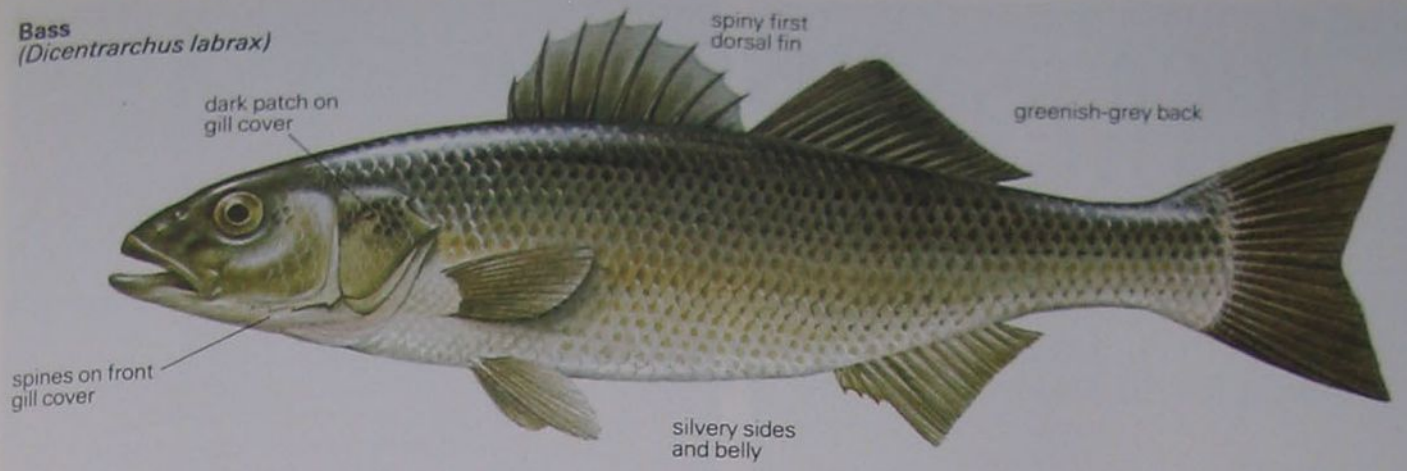
It is a predatory fish, adults feeding on sandeels, other small fishes and, when close inshore, crabs and shrimps. However, its range of diet is wide and almost anything that moves and is a convenient mouthful is fair game to a hunting bass. Feeding is heaviest during the summer and often ceases altogether in winter when sea temperatures fall and bass become inactive.

During the summer, bass are found in the Thames estuary, all along the south coast and up the west coast as far as Cumbria, though there are scattered pockets of bass further north.

In the autumn, the adult bass migrate to warmer wintering areas, returning the following spring to their summer breeding grounds. Most British bass migrate along the coast to winter off western Cornwall, except for a small group in the south-east, some of which migrate across the English Channel to France.

Spawning Again, our knowledge of spawning and the subsequent early development of bass is not complete. Spawning appears to take place in May or June, the females laying their eggs over a period of several days. The eggs float on the water and, after about four days, they hatch into larvae about 4mm long. After another six days the larvae become free-swimming.

The larvae mature into fry, which migrate into estuaries and creeks, where they spend



the next two years in brackish water and occasionally even enter fresh water. In their third year, the fry begin to venture further afield and become increasingly coastal in their movements.

The final departure from the estuary comes in the fifth year, when large assemblies of adolescent bass gather at estuary mouths. They then enter upon their adult lives, mainly frequenting coastal waters but visiting estuaries occasionally in the course of their normal hunting travels.

Slow growth In the cool waters around the British Isles bass grow much more slowly than they do in the warmer waters of the Mediterranean. There, a six-year-old female will weigh 2.5kg (5lb), against a British specimen of the same age weighing typically 700g (1½lb).

Like their elders, young bass have a wide-ranging diet, though they are particularly fond of shrimps. At the end of their first year, they measure about 7cm (2¾in) long, and a year later have doubled to about 14-15cm (5½-6in).

Bass can live for perhaps 20 years or more, reaching a usual length of about 60cm (2ft) and weighing 4kg (9lb), though very much heavier bass have been caught.

The effect of weather The weather plays a vital role in the maintenance of bass stocks. A warm summer means good growth and (usually) successful spawning. Really strong year-classes occurred in 1959 and 1976, both years in which there were warm dry conditions during spawning and for a month or so afterwards.

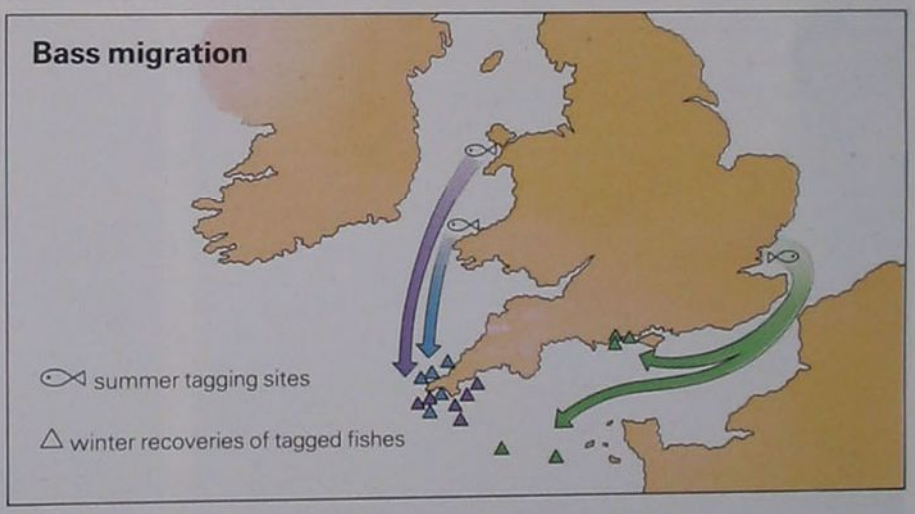
Coversely, poor year-classes occur during cool, unsettled summers, and in extreme cases spawning may be a total failure. The worst example of spawning failure in recent years was in 1963, when an exceptionally severe winter extended well into spring, leading to the elimination of the 1963 class and also of that of 1962 due to the freezing up of the nursery areas.

The future The most serious threat to the recovery of the bass population is gill-nets. Made from transparent nylon and therefore virtually invisible in water, they are the most efficient means yet of catching bass. Many traditional line-fishermen have set their faces against them, fearing that in the long run they could destroy their livelihoods, but others are less scrupulous, and they have been joined by a small army of spare-time netters attracted by the high price which bass command.

Despite the growing pressure, bass are not likely to disappear from our waters. The serious drop in standards of shore angling over the past three decades seems to have levelled out. Laws have been introduced limiting the size of bass that can be taken; it now stands at 30cm (12in) fork-length, and will be increased in 1983 to 35cm (14in). The higher figure already applies in Cornwall.

Above: The bass's clearest distinguishing features are its spiny first dorsal fin, the teeth on its lower front gill cover and the dark patch lying on the rear of the gill cover.
Typically, an adult bass is about 60cm (2ft) long and weighs 4kg (9lb).

Right: The bright red gills of a bass. The white, forward-pointing structures lying in front are the gill rakers, which act as sieves to trap particles.



Above: By tagging bass in their summer breeding sites and recovering them in the winter, much has been learned about their seasonal movements. Those breeding along the west coast winter off western Cornwall. South coast bass are believed to do the same, but in the extreme south-east British bass are joined in some summers by bass from north-west France. In the autumn the south-eastern British bass migrate along the south coast and the French bass return to France.

FOUR SEASONS IN THE FOREST

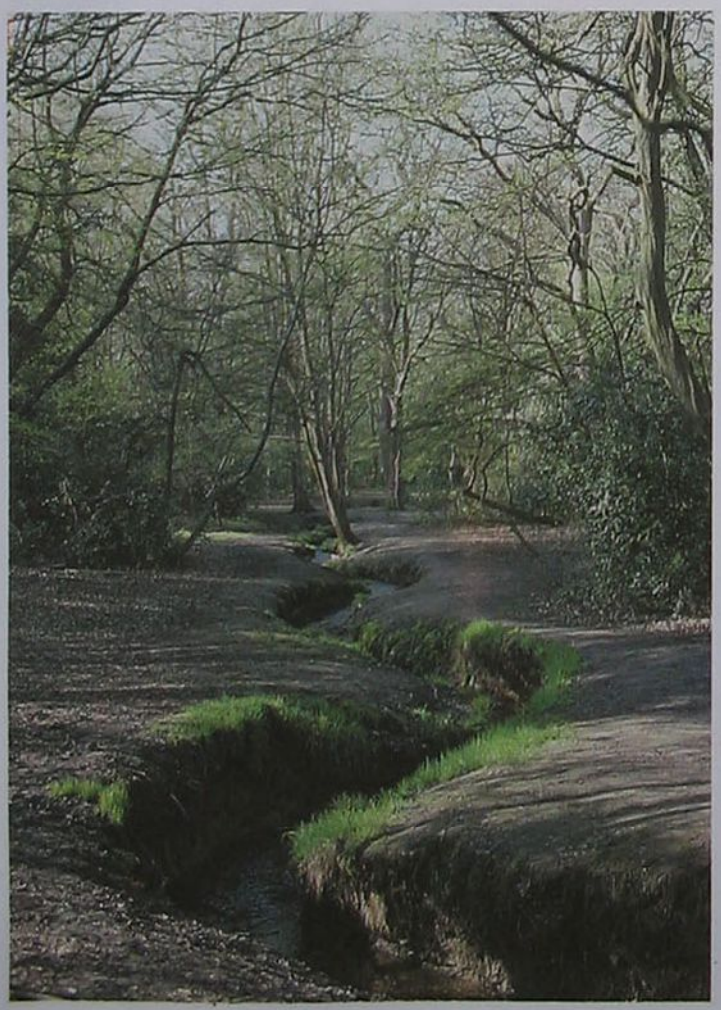
Epping Forest, sometimes called London's Forest, is, at its nearest, only six miles from the centre of the city. The seasons there are well-marked, each one presenting the forest in a new light and each with new problems for the plants and animals to solve.

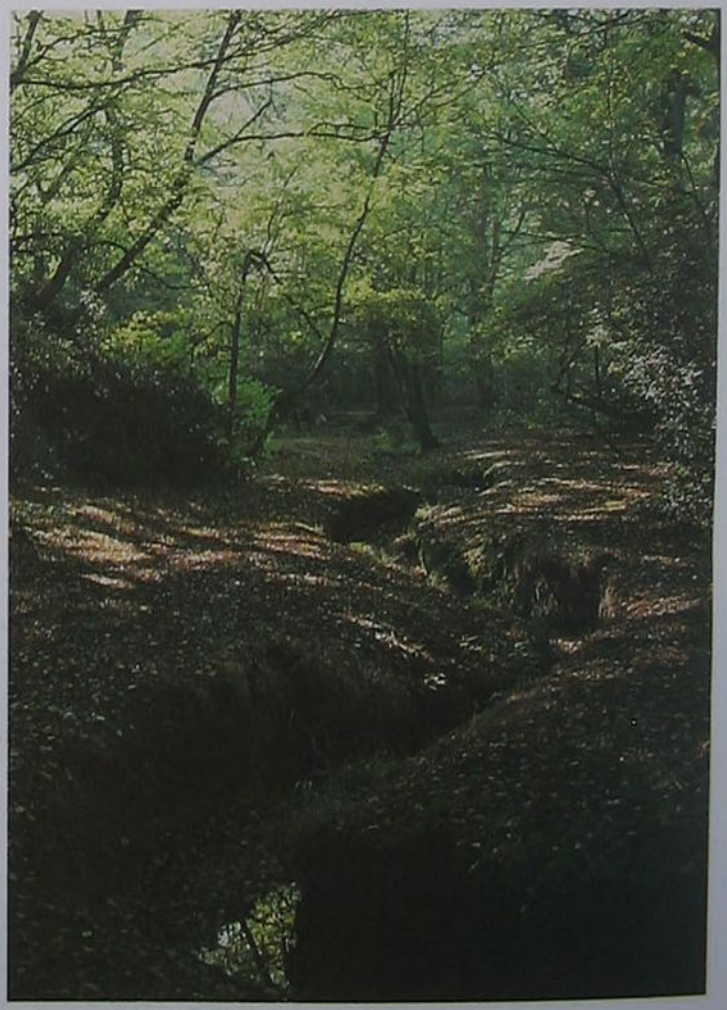
Below: Epping Forest clearly reflects the external and internal influences of each of the different seasons. The differences are obvious, even in this small glade ringed by beeches, holly and hornbeam and dissected by a small stream. The new young leaves of spring are just appearing (left), but by the middle of summer they form a shady canopy which allows very little light through (right).

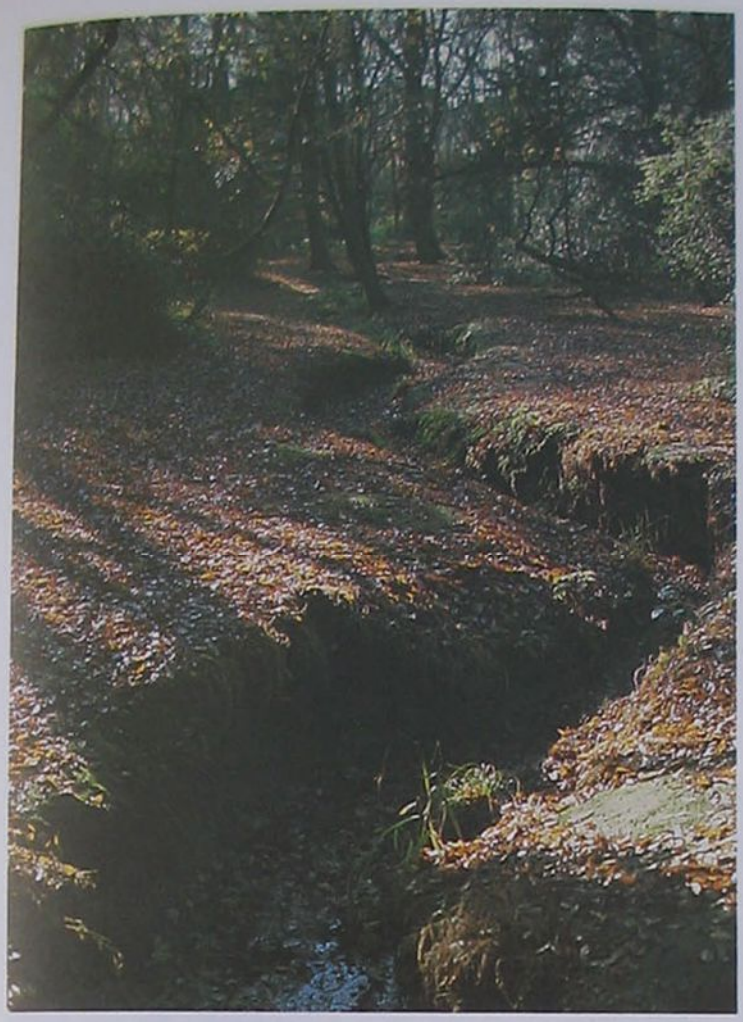
An area of old woodland, probably well-grazed by cattle before the Normans came, Epping Forest has been managed mostly by the ancient custom of pollarding to provide wood fuel. This original system of management ceased a hundred years ago and the forest is now largely one of old pollards and younger trees with branches growing high to reach the light. Four species – oak, beech, birch and hornbeam, with bramble and holly as undergrowth – comprise most of the forest. The flora and fauna – even in the small glade with a little stream that we look at here – is rich.

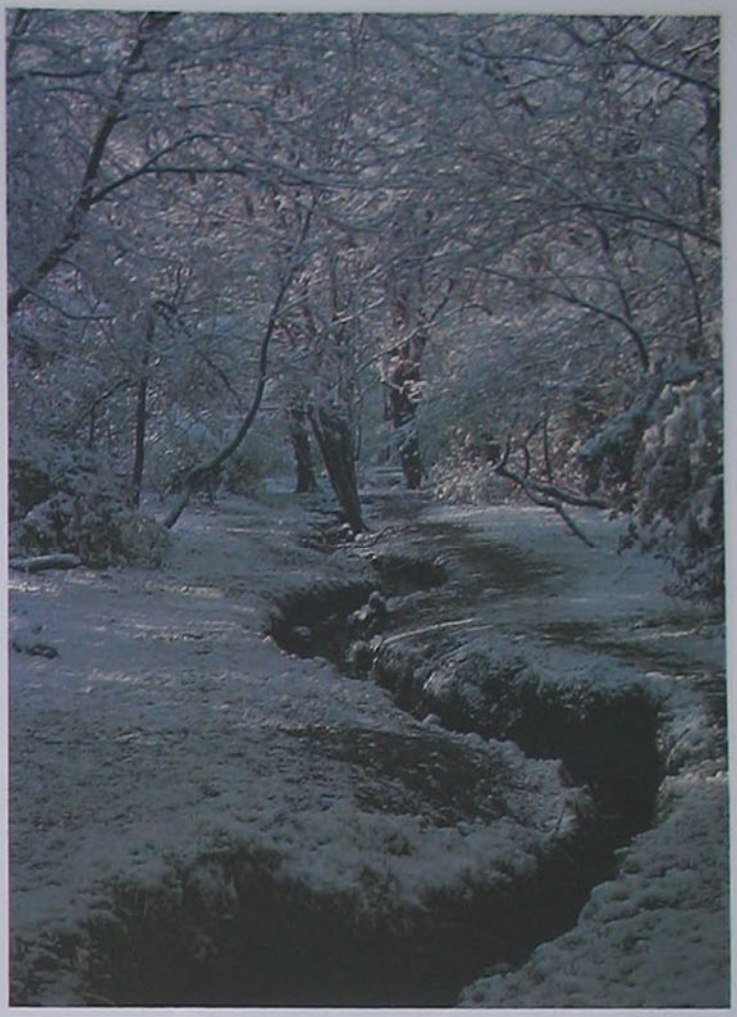
Autumn – season of fruitfulness At the end of August the first signs of autumn appear – withered horse-chestnut leaves, bleached grass, dew-covered spiders' webs and yellowing sunlight all warn that summer is almost over. The summer's growth culminates with fruits – blackberries, sloes, conkers, rose hips and others decorate the thickets, while tree branches hang low with beech nuts, acorns and, on the hornbeam, winged seeds. Animal populations are high, for food for mammals, birds and insects is still plentiful.

However, as soon as the first frosts appear, such creatures as grasshoppers vanish, along with the dragonflies and other insects that cannot withstand the cold. There now begins a period of waiting – and surviving – with the next generation's existence ensured in various ways. The grasshopper's future lies with its eggs, tucked into the soil, while dragonfly nymphs are secure in ponds; and annual plants have already set seed that will germinate the following spring. But individual creatures that live longer than one season need to change their behaviour in preparation for the harder times of winter. Young, almost adult, foxes seek their own hunting grounds and become independent, while hedgehogs and dormice evade the rigours of winter by hibernating. And family parties of many species of birds start to break up in autumn to merge into larger mixed flocks. The territories of such paired birds as the robin are revised as males and females start to defend individual areas. The juveniles too, after the July/









August moult, establish territories. Perennial plants, responding to colder temperatures, die back to await the coming of warmer weather to produce new shoots.

Jays at this time of year often fly to and fro across the forest clearings, carrying acorns which they bury in grass and undergrowth. Squirrels, too, make caches of acorns and beech nuts. Almost certainly these caches are not remembered but merely re-discovered, and then not necessarily by the same individuals. In the spring that followed the hot summer of 1976, when many of the beeches in Epping Forest produced masses of seed, small tight clumps of beech seedlings marked the spots where buried squirrel collections had not been re-discovered.

The appearance of fungi in the autumn woods can be held back and severely restricted if an 'Indian summer' in September creates dry soil conditions, but a sudden 'blossoming' will occur when rain dampens the soil. The toadstool that we see above the leaf-mould is the fruiting body which produces millions of spores, a vast microscopic mixture of which is dusted about the woodland each year.

The autumn colour change in this part of the forest, usually occurring in the last week of October and the first week of November, is at its most spectacular as the yellows of the hornbeams and birches turn to golden browns and the beeches assume a rich coppery tan.

Winter waiting Once the trees are bare winter has arrived. It is a season of waiting and surviving–waiting for the sun and warmth essential for growth to begin again, and for the survival of the fittest.

Winter is perhaps the time when the greatest levelling of populations occurs, as harsh conditions settle in. When the ground is hard and the water frozen, the old and weak and then the least strong and the unlucky fall victim to the hostile environment. These mounting losses are necessary to restore a delicate balance. For instance, the two blue tits that nested in the hornbeam by the stream had 10 young–a 500% increase in population

Above: The seasons progress in the beech/hornbeam glade: autumn leaves carpet the ground and the trees look suddenly bare (left), while in winter there is a carpet of a different and harsher kind–snow (right).

Below: Wood sorrel, with its three-part leaves that often fold up. It flowers from March to May in the woodland glade.

Left: In spring, before the leaves of the beech trees blot out the sunlight from the ground, you may find a few clumps of bluebells scattered here and there among the bracken and brambles in the glade. The summer of 1976–exceptionally dry and hot–had a marked effect on the rather shallow root systems of many beech trees. The roots did not reach far enough into the ground to find the water that remained deep down and the trees therefore suffered badly from the drought. The recovery of these trees after 1976 was only partial and many of the giant old beeches are dying and will eventually topple over. As more light will then reach the ground, more bluebells may appear.

that would be disastrous if all members of such broods throughout the country were to survive.

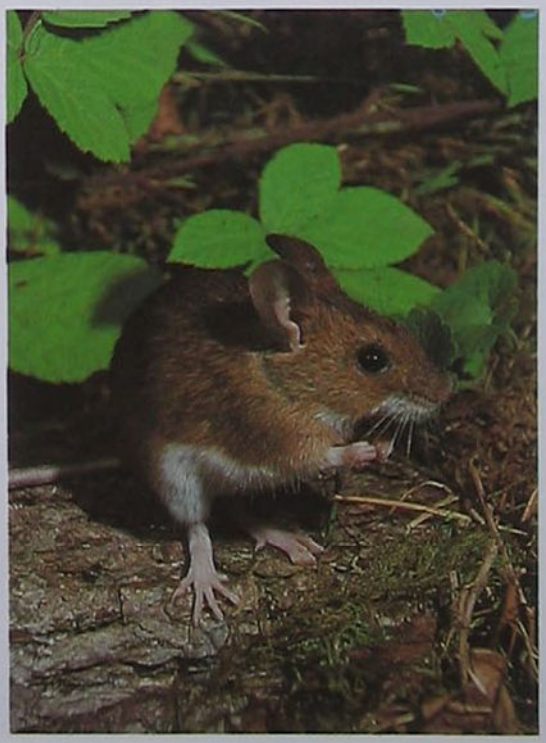
In the ground, under the bark, deep inside the wood and even inside buds, the population of invertebrates is waiting, also endeavouring to survive. Under the bark of one dead oak, a queen wasp hibernates, and also present are two species of spiders–but all that remains of a golden-eyed lacewing fly and a chestnut moth are their wings. The lacewing is the only one to overwinter as an adult insect and the remains of its wings show that it had tried to hibernate but had been eaten, thereby providing the means of helping the spiders survive.

Later on a patch of light snow on the bank of the stream can provide a record of some of the mammals and birds that passed by in the night. In this square metre of snow you may see the clear tracks of a fox that had followed the bank, the trail of a brown hare crossing the stream, or the markings of a squirrel that came to drink, and the prints of a small bird (possibly a robin) and nearby the star-shaped tracks of a wood-mouse as well. By following stoat tracks in and out of a bramble patch leading to the roots of a fallen tree you could also find the long mark of a wood-mouse's tail, indicating that the stoat had been carrying its victim in its mouth. Fluttering wing-prints and dried blackberry seed-husks on the snow may indicate where bullfinches had been feeding.

Signs of spring Sometimes, before the snow has gone in late January, the first flowers can be seen on the butcher's broom plants in the glade. Each small clump of sprays shows either male or female flowers. By February, mosses are producing new growth and soon start to 'fruit', and such liverworts as the crescent-cup and *Pellia epiphylla*, growing on the banks of the stream, will both be in fruit.

In the usually drier days of March you can hear the creaky, wheezy whistling, interspersed with explosive ticks, which is the 'song' of the hawfinch, an uncommon bird that likes to perch in the hornbeams and oaks above the stream. These finches, and others, as well as tits and robins, will soon be pairing off and beginning nesting activities. Hibernating mammals–the hedgehog and the dormouse–reappear, hungry and anxious to regain the weight they have lost, while foxes and all the smaller mammals start looking for mates.

The cold, rather acid, clay soils–and over a century of visitors–have resulted in the forest having a rather poor showing of spring flowers. Lesser celandines, wood-sorrel and dog's mercury grow beside the stream, and in the brambles and bracken a scattering of bluebells is trying to make a comeback. However, the primroses and wood anemones have long since disappeared. But, to compensate for this lack of flowers, the new young leaves



Above: A flower to look for in summer in the forest is the honeysuckle. The delightful scent of this plant is at its strongest at night; indeed, at twilight or later in the evening, the scent will guide you to the honeysuckle.

Left: There are yellow-necked wood-mice in Epping Forest, as well as the more common wood-mice. The summer bounty of beech nuts is one source of food for them, but they also feed on blackberries, acorns and the winged seeds of the hornbeam. As its name suggests, you can identify the yellow-necked mouse by its orange-yellow 'collar' and throat patches.

of the beech and hornbeam spread a haze of light green throughout the glade.

Summer–a time of burgeoning The year seems to accelerate rapidly during late April: by May the tree canopy is complete and, before the end of the month, the leaves have darkened and the forest floor is cut off from the sun until the October winds thin out the leaves.

This is true in most years. But in certain years, such as in 1982, conditions were right to produce a plague of defoliating caterpillars. These are the larvae of such small moths as the green tortrix, the mottled umber, the winter moth and the spring usher. It is thought that among the most favourable circumstances for the caterpillars must be the exact synchronisation of the opening of the leaf buds with their hatching. In the years when this happens some oaks and hornbeams are almost completely stripped of leaves and the trees produce a second growth of foliage. This later growth is usually so remarkably free of invertebrate life–both herbivores and predators–that it emphasises the enormity of the impact of the event upon other species of life in the trees. This is in spite of the host of birds feeding on the caterpillars for, apart from the tits and warblers in the leaf canopy, thrushes, blackbirds, robins, magpies and jays will also feed as the caterpillars drop to the ground to pupate.

At the beginning of June a strange, heavy scent in the woodland can be traced to holly flowers which, like those on the butcher's broom, reveal male and female flowers on different bushes. The red campion clump that grows in partial shade at the edge of the clearing also has single-sexed flowers.

A quiet descends on the woodland in high summer; birds have finished the frantic feeding of their young, the sun can only reach the ground where a dead or fallen tree leaves a hole in the canopy and, where the bramble is in flower, the soft, steady hum of insects can be heard. The foetid smell of a freshly emerged stink-horn fungus, already capped with a covering of flies, is an early sign that summer is passing rapidly, as are the first pink spikes of rosebay willowherb, the appearance of large dragonflies (perhaps the bronze-winged *Aeshna grandis*), and grasshoppers buzzing in the grasses where the cocoons of the hunting spider *Pisaura mirabilis* have enclosed the heads of a tuft of wavy hair-grass and are already filled with minute baby spiders. Soon autumn will start to tint the leaves and the first chills will be felt in the air.

Above: The appearance of fungi in the autumn glade attracts a grey squirrel on the look-out for a feast. Being a relic of ancient, mixed broad-leaved woodland, with a soil that has been relatively undisturbed for centuries, Epping Forest is extremely rich in fungi. This is hardly surprising since it has been estimated that one 10cm (4in) toadstool cap produces some sixteen thousand million spores.

Left: A robin sitting on a snow-covered branch–a common sight in winter (and not just on Christmas cards). Of all woodland birds the robin is the most famous for singing throughout the year (except in July and early August). Singly, or in pairs, robins maintain territories through all four seasons. Other birds, too, may be heard singing in autumn and winter, among them the song thrush, the dunnock and the wren. This is, indeed, the time to learn to recognise and distinguish between the songs of these four birds–while they cannot be confused with those of other birds.

FEATHER-WINGED PLUME MOTHS

Plume moths – quite unlike any other species of moth found in the British Isles – have wings that are split into distinct lobes or plumes and look superficially like tiny feathers. They are delicate creatures and, as they fly by night, they are only seen if disturbed from their daytime resting place.

Below: The distinctive large white plume (*Pterophorus pentadactyla*) is the plume moth seen most often. It has shiny white wings and body, spurred legs and black eyes. It attracts immediate attention, both because it is so glaringly white and also because it is one of the larger species, with a wingspan of 3cm ($1\frac{1}{8}$in). This moth is at rest with its wings slightly closed so that only two of the five feathery plumes can be seen.

There are about 35 species of plume moth found in the British Isles. They all belong to the family Pterophoridae, apart from one species which belongs to a separate family, the Alucitidae. This moth, the many plume, differs from the others in having its wings divided into 24 plumes, while all the other plume moths have each forewing divided into two plumes, and each hind wing into three.

Delicate night-flyers Plume moths are rather small with long, slender bodies and large, conspicuous legs bearing sharp spurs. At first sight they do not look like moths at all, resembling small craneflies, particularly when in flight. Few of the species have distinctive markings and they are thus by no means easy to identify.

The moths fly at night and are readily attracted to bright lights. During the day, they may be disturbed from the vegetation where they rest, and after a short flight to escape the disturbance, they settle on a leaf, fence, or tree trunk.

The caterpillars feed on leaves, flowers or within stems, depending on the species, and each tends to be restricted to a single species of food plant, or a group of related plants. One caterpillar, that of the marsh plume, feeds on sundew – an insectivorous plant – but seems to thrive despite the inherent danger of living on such a plant.

Honeysuckle dweller Several species of plume moth occur in gardens, among them the many plume, a tiny moth but unmistakable because of the 24 plumes of its wings. In the past, it was presumably a woodland species, as the caterpillars eat nothing but honeysuckle, a plant once confined to woods. As honeysuckle is now common in gardens, the moth appears there too. It is found throughout Britain and is abundant in many localities.

The caterpillar is pink, with a dark-spotted, pale brown head. It is found among the flower buds and flowers of honeysuckle, where it feeds chiefly on pollen, an unusual food for moth caterpillars. When fully fed, it pupates on the ground beside the food plant, first constructing a cocoon within which it is well hidden.

The moths hatch from the pupae in summer, then hibernate, only appearing with the first warm weather in the spring. They are sometimes attracted to lights on mild nights in winter, but are more often found sitting motionless in secluded spots in sheds and greenhouses, or in crevices on fences and

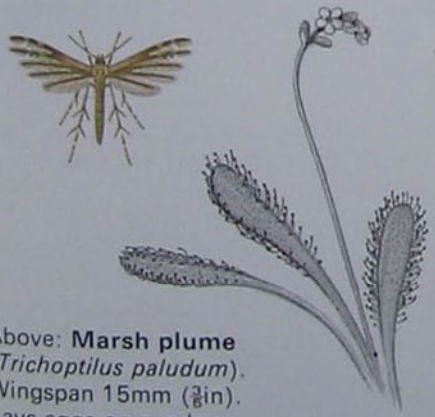
Above: The tiny many plume (*Alucita hexadactyla*), with a wingspan of only 15mm ($\frac{3}{8}$in) is recognisable by the 24 plumes of its wings. Although well camouflaged, it can sometimes be seen sitting motionless on a wall or fence.

Insect feeding restrictions

The caterpillars of most species of plume moth are restricted to just one species of food plant, and the same is true of many other plant-feeding insects.

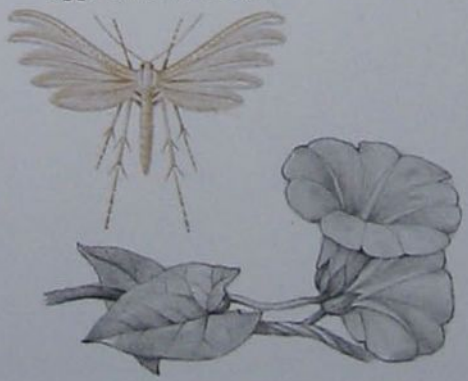
Virtually all plants produce some chemical substances in their leaves which play no part in normal growth and development, but which seem to act as deterrents to insect attack. Thousands of different types of these chemicals are known. During the course of evolution, insects have developed the ability to overcome the toxicity of certain of these chemicals so that they can feed on a particular plant without adverse effects – hence the often narrow range of food plants to which many species are restricted.

The distinctive flavours of many of our foods and beverages are caused by the presence of such chemicals and some insecticides are actually made from these naturally occurring defensive substances, for instance pyrethrum which is derived from plants of the daisy family.



Above: **Marsh plume** (*Trichoptilus paludum*). Wingspan 15mm ($\frac{3}{8}$in). Lays eggs on sundew.

Below: **Large white plume** (*Pterophorus pentadactyla*). Wingspan 3cm ($1\frac{1}{8}$in). Lays eggs on bindweed.



Above: **Brown wood plume** (*Stenoptilia pterodactyla*). Wingspan 2.5cm (1in). Lays eggs on germander speedwell.

walls. The best way to see the moths is by gently tapping honeysuckle bushes in August and September. Any moths disturbed will emerge and fly a short distance, settling on nearby leaves.

Distinctive species The large white plume is easily recognised by its larger size and brilliant white coloration. It is common in England and Wales, flying from June to July.

The female lays her eggs on the leaves of bindweed, often in hedgerows. When the caterpillars hatch, they feed for a short time, but hibernate while still small. Bindweed dies back during the winter, and the caterpillars start feeding again in spring when the first new leaves appear above the ground. The caterpillars are bright green with yellowish stripes, and are covered with tufts of whitish hair. When fully fed, they form pupae which resemble the caterpillars but are, of course, unable to feed. They are immobile unless provoked, when they jerk their thorax.

Plant-mining caterpillar With its pale brown wings, legs and body, and forewings with a dark spot in the middle, the garden-dwelling ochreous plume resembles several other plume moths which also inhabit gardens. The ochreous plume is fairly common in England, inhabiting wasteland as well as gardens. It flies during the night in August, and although it can be disturbed from vegetation during the day, it is much more likely to remain still and so escape detection.

Above: The triangle plume (*Platyptilia gonodactyla*) takes its name from the dark mark on its forewing, which is usually triangular in shape. Two generations of this moth appear each year, the first in May and June and the second in August and September.

Below: A mating pair of brown wood plume moths (*Stenoptilia pterodactyla*). Plume moths lack the bulky appearance associated with moths and are more delicate, like craneflies.

The caterpillars have a distinctive lifestyle. The female moth lays her eggs on the flower heads of tansy, a common plant of wasteland and gardens. After hatching, the young caterpillar bores a mine down into a flower stem to hibernate in the root. Feeding recommences in spring when the caterpillar continues to mine, eating the internal tissues of the stem and sometimes causing it to wilt. When fully fed, the small, brown caterpillar leaves the mine and comes out into the open where it forms a pupa attached to the stem.

Triangle plume The caterpillars of the triangle plume also mine into the stems of their food plant, and into the leaves and flowers as well. The female lays her eggs on the leaves and stems of coltsfoot. The caterpillars, which are whitish with black dots, hatch in September and at first mine into leaves, then later into the stems, where they hibernate. In spring they mine into buds and flower heads, eventually pupating in the seed head.

However, there are two broods of moths each year, and caterpillars resulting from the first brood mine into leaves in June and July, when coltsfoot is not in flower. The pupae of this brood are therefore formed inside silken cocoons on the underside of leaves.

The moth resembles the ochreous plume, but the dark spot on the forewing is usually triangular in shape. The first brood flies at night in May and June, and the second in August and September.

The brown wood plume This is similar in appearance to the two species described above, but lacks the dark spot on the forewing. It is common in Britain, especially in the south, where it is found in gardens, hedgerows and woodland edges, provided there is a plentiful supply of its food plant, germander speedwell.

The female lays her eggs on the underside of the leaves of the plant. After hatching, the caterpillar bores into the stem and hibernates in a hole which it makes low down in the stem, first constructing a protective cocoon. In spring it leaves the cocoon and climbs up the plant to feed on the bright blue flowers. As its coloration resembles that of the flower, it is not easy to see.

ROADSIDES: PLANT HAVENS

The thousands of miles of roadsides throughout the British Isles represent a large total area and a wide range of habitats. They play an important role in conservation, providing our plant species with room to grow in relatively stable conditions.

Above: Some roadside plants grow best in light shade, or in places where they are shaded for part of the day. Red campion is one such species, growing on shady banks and along hedgerows. It is seen growing here with ramsons (*Allium ursinum*) which smells strongly of garlic or onions, and meadow buttercup, a damp-loving species. Although these species can be found elsewhere—often at the edges of woods—they are very typical roadside flowers.

Roadsides and motorway verges are not simply green fringes to the tarmac; they are made up of a series of different habitats which lie close together, parallel to the road. There is usually a grassy verge or bank, a ditch, and a hedge, although not all these habitats are necessarily present at the same place. Hedges, for example, are common along many roads but in areas such as the Peak District and the Yorkshire Dales they are replaced by dry stone walls, and on certain moorland roads they are absent altogether.

Local geology and geography are important factors, affecting which plants are found along any particular stretch of road. Different soils support different floras, and an open, sunny aspect favours some species more than others. While certain species will grow on almost any type of roadside, others are more restricted and can be used as habitat indicators.

Dry, grassy verges Open, grassy roadsides are often dominated by umbellifers (members of the carrot family). Three common species provide a continuous display of lacy, white flower heads throughout the spring and summer. Cow parsley appears first, flowering from April until June, when it gives way to rough chervil. In July the third species, upright hedge parsley, appears and continues to bloom until September.

Members of the daisy family are typical of sunny banks and verges. Burdocks, thistles, tansy and yarrow are all common here, and the large white flowers of the ox-eye daisy make an attractive show. Both daisies and dandelions grow well in the full sun. However, they are abundant only where the grass is kept short by regular mowing. Their low-growing rosettes escape the cutting blades, but they are rapidly shaded out if grass and taller flowers are allowed to grow.

Acid and alkaline soils Where the underlying soil changes in composition, the same sunny banks and verges support new species. Harebells and ling may appear on acid soils, while in chalky areas, purple-flowered knapweed is common. In the north and west, a typical plant of alkaline soils is the meadow

crane's-bill. It is locally common and can be abundant on long stretches of road, where it is said to 'haunt the verges like an encampment of gypsies'.

Two rather rare species are good indicators of the chalky nature of a roadside. Chicory is a tall plant with flowers resembling those of the dandelion, but an unmistakable pale blue in colour. Dark mullein is another tall plant with a rosette of large, felted leaves and a long spike of yellow flowers with hairy, purple stamens. Both species are restricted to chalky areas, although chicory does occasionally grow on sandy soils.

Damp and shady banks Many roadside plants dislike dry conditions, but will tolerate sunny positions where there is an adequate supply of water. Comfrey, for example, grows on open banks and verges where the underlying soil is damp. Meadow buttercup has similar requirements, preferring wetter conditions than the other common roadside buttercups.

Most damp-loving species are found in shady places along the road. Adequate shade can be provided by a hedge, a wall and even a steep bank or, of course, a wood if the road happens to pass through it.

Deeper shade favours woodland species and where conditions permit, they are common roadside inhabitants, especially along old hedgerows. Ground ivy, dog's mercury and wood anemones carpet damp, shaded banks and the glossy, arrow-shaped leaves and greenish hoods of lords and ladies (wild arum) are a familiar sight. In spring, many well-shaded roadsides are brightened by bluebells.

Ditches and hedges Probably the least well-known of roadside habitats are ditches, simply because we are seldom able to see them from the road. The main ditch runs parallel to the road, sometimes connecting with secondary ditches or storm drains cut into the verge at right angles. As the plants grow higher during the summer, all but the widest ditches are gradually overgrown. Very shallow ditches dry out quickly and the plants in them differ little from those of the neighbouring verge, but deeper ditches can support species more usually found by streams and rivers, such as great willowherb and purple loosestrife.

Many of our roads are bounded on either side by hedges. These are commonly of hawthorn which can prove an impenetrable barrier, but some shrubs such as blackthorn, dog-rose and elder flourish there. As well as providing shade and protection from wind, a hedge also provides support for climbing plants. Small climbers such as vetches and bindweed will scramble among the grasses and herbs of the verge, but more robust species such as hops and hedge bindweed are vigorous climbers.

Growing conditions Roadside plants face two major hazards–mowing and pollution–both resulting directly from the proximity of the highway. In order to provide motorists with a clear view the grass verges are usually mown twice a year, particularly at junctions and on corners and bends.

Most plants growing on verges flower after the spring mowing, and have dispersed their ripe seeds before the late summer or autumn mowing. Where more regular cutting occurs, the only species that flourish are those which can avoid damage, such as daisies and dandelions, or those which grow again rapidly, such as yarrow.

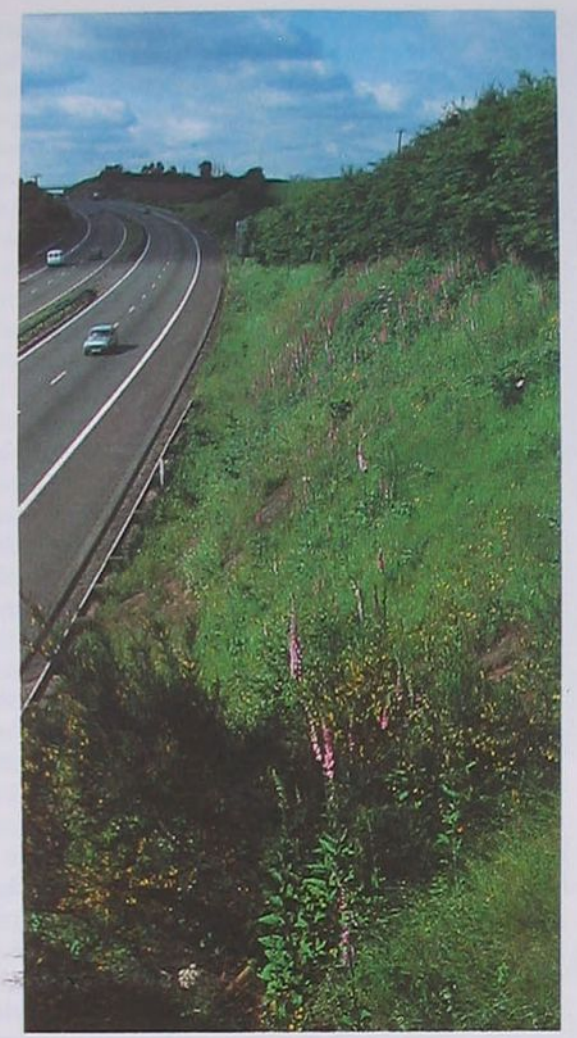
Pollution Roadside pollution is only likely to be a problem on the busier roads, but it is causing increasing concern. There are a

Above: The attractive mauve, white or pink flowers of comfrey (*Symphytum officinale*) appear from May to September on roadsides where the underlying soil is damp.

Left: Yarrow (*Achillea millefolium*) is a common species on sunny, grassy verges. It grows well on mown strips for although the flowerheads are tall enough to be cut off, this does not greatly damage the plant and it soon recovers to flower again.

Above: Common fleabane (*Pulicaria dysenterica*) is frequently found on marshy ground throughout Britain. It is also found in roadside ditches, where it flowers from August to September. Fleabane was once highly valued as an insecticide; the vapour given off when the leaves were burned was supposed to drive away fleas –hence the plant's common name.

Right: Motorway verges are planted initially with grass, which is cared for until it is well-established. After this, the verges are left alone. Pedestrians have no access to motorway verges and so plants growing there have an advantage over those growing on ordinary roadsides, for the flowers are unmolested once mowing has ceased. This is particularly important for the rarer species, and those such as primroses which suffer from overpicking elsewhere.



Below: Ditches that are overgrown or shaded by trees and hedges are cool and damp. They enable species usually associated with stream-sides and water margins—like the tall spikes of purple loosestrife seen here—to grow and spread along otherwise dry roadsides. The hedge not only provides shelter, but acts as a convenient support for such climbing species as brambles and hedge bindweed.

variety of different pollutants, one of which—dust—is common but frequently overlooked. Layers of dust stirred up by passing cars can clog leaves, interfering with photosynthesis and gas-exchange.

The exhausts of petrol-driven cars emit a variety of polluting gases and chemicals, including oxides of nitrogen, some of which are poisonous to plants causing leaf lesions and discoloration. The effects of such polluting gases may spread many miles from the original source.

Engine oil is toxic, and spreads as droplets on vegetation. Oil and chemical spillages can also affect roadside ditches when they are washed into them from the road.

Motorway flora The problems for plants growing beside a motorway are exacerbated by the construction of the road and the volume of traffic which it carries. However, the hard shoulder acts as a buffer zone against some of the pollution, and the effects on the plants may be no worse than on those species that grow beside busy urban or trunk roads.

One additional hazard faced by motorway species is the salt used to keep the carriageways clear of ice in winter. High salt levels are injurious to most species, and there is often a bare strip along the hard shoulder caused by salt-burn. Salt-marsh species such as sea-aster, which can tolerate high salt levels, are now beginning to appear along this strip on some motorways.

HARDY, THRIFTY CELTIC CATTLE

The one common characteristic of Celtic cattle is their ability to live in upland areas on marginal land. These ancient cattle had become unfashionable over the centuries, but they are now finding favour again in a changing economic climate.

Above: Dexter calves. The Dexter's exact origins are uncertain but the earliest record of the breed was in Ireland in the 18th century. 'Celtic' cattle in fact probably preceded the Celts by many centuries. They reached Britain around 2000BC, maybe brought by the Beaker People and megalith builders who were responsible for building Stonehenge and similar monuments. However, they were adopted by the Celts, and migrated westwards with them in the face of subsequent invasions. As a result they were not kept by later generations of more progressive breeders, and were not subjected to the same artificial selection pressures as the more popular breeds.

The short-horned cattle introduced in relatively recent times to the British Isles are now the dominant breeds here. The Shorthorns and Friesians, first imported from the Low Countries about 400 years ago, have displaced the native dairy breeds, while the contemporary interest in exotic beef breeds is filling British pastures with cream and mushroom coloured animals.

Old-established breeds, known colloquially as Celtic cattle, were long ago pushed to the western and northern fringes of the country, where they continued as minority breeds. In recent years interest in conservation has focused attention again on these old breeds, and they now thrive in small numbers in many areas.

The different breeds of Celtic cattle survived in limited areas, becoming adapted to the peculiar conditions under which they were reared. The Kerry is a black specialist dairy breed, whereas the Kyloe is a dun-coloured hill breed intended primarily for meat production. However, all the breeds are hardy, thrifty cattle that can live in areas of low fertility. Although their yields and standards of production are relatively modest, they can live where more popular breeds would not survive.

The Kerry is found mainly in south-west Ireland, with the largest herd in Muckross Park on the shores of Lough Leane at Killarney. A hundred years ago the Kerry was the dominant breed in Ireland, but its territory was gradually reduced until it was confined almost solely to the Dingle Peninsula.

The Kerry has a lean and angular conformation, typical of dairy breeds. It is relatively small. The bulls are temperamental and aggressive, also a characteristic of dairy breeds. The colour is black, although it has not always been so. A century ago colours such as brown, and also extensive white markings, were found within the breed. The cattle have an alert demeanour, enhanced by slender, graceful, uptilted horns. Their style and appearance is well attuned to the wild and beautiful hills of their native area.

Kerry cattle are noted for their longevity and high yields of milk in relation to their size. Brookwood Primrose yielded 46,250kg (102,000lb) of milk in her lifetime–approximately 125 times her own body weight. The Kerry is a specialist dairy breed, with no pretensions to meat production, and it is likely to continue as a smallholders' cow in those areas of Ireland which will not support larger, more productive breeds. It is well

Kerry 370kg (about 6½cwt); found mainly in SW Ireland. Specialist dairy breed. Always black.

Dexter 300kg (nearly 6cwt); found mainly in SE Ireland. Good household cow for milk and beef. Usually black.

suited to systems of production that do not rely on expensive high-energy feeds.

The Dexter is closely related to the Kerry, but its exact origins are uncertain. The earliest record of the breed was in Ireland in the 18th century. It resembles a short-legged and beefy type of Kerry, the small size being partly associated with a 'dwarf gene'. The legs are short and the conformation may be deformed to a varying extent when the dwarf gene is present. Compared with the Kerry, the head is short and broad, and the body deeper and more compact. The horns are shorter and less graceful. Black is the most usual colour, but red and dun specimens are also found.

The Dexter consumes little more than half the amount eaten by larger breeds. Because of its light weight it causes less damage to the land, and can be managed more easily by a stockman. The average yield of milk is 2,300kg (5,070lb) per lactation. It is suitable for use as a house-cow, yielding sufficient milk in early lactation for its own calf and a typical family, and for a household alone after the calf is weaned. The steers fatten easily and produce small joints. The breed is popular in self-sufficiency systems, and in farm parks and amenity centres.

The Kyloe or Highland is another favourite breed in farm parks. Its long shaggy coat, with a fringe of hair falling over its face, the teddy-bear appearance of the young calf and the long wideswept horns, ensure its popularity with visitors. The usual colour is now a dun, with a few yellow/white, brindle or black animals, but the dominance of this colour results from selection determined by fashion: originally most animals were black.

The modern breed evolved from the fusion of two types. On the mainland of Scotland there was a larger type, known as the West Highland, while the smaller animals found on the islands gained their name (Kyloe) because they had to swim the kyles (straits) to reach the markets on the mainland. The long hair is essential to enable the cattle to survive the harsh conditions in the Highlands and Islands. The Highland is probably the hardiest British breed of cattle.

Females usually produce their first calf at three and a half years of age, compared with two or two and a half in more productive breeds. They mature slowly and late. In contrast to the Kerry breed, it is the Highland cows, not the bulls, that are aggressive.

The Shetland breed evolved in the northernmost part of the British Isles. It was given shelter by crofters, but had to survive on a limited amount of low quality feed, so it has become an efficient converter of poor roughage food. It provides a good yield of milk in relation to its size. It can do well on indifferent pasture and the beef is noted for its flavour. The size varies greatly, and the most universal colour is black and white, but only 50 years ago the range of colours included dun, red and white in a variety of patterns.

The temperament of the Shetland has been influenced by its close association with its owner. A cow often became so attracted to the wife of the crofter that a square of her apron had to accompany the animal when it was sold before it would accept its new owner, and became known as 'clouty cow'.

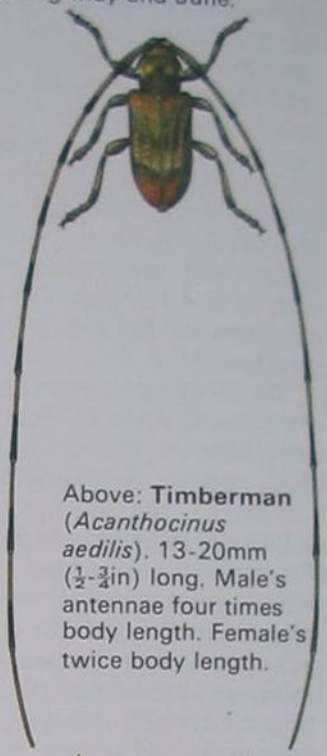
Above: A Belted Galloway. Galloway cattle are well protected by their long outer coat of hair, which sheds the rain, and a dense, tight undercoat beneath, which prevents the wind from penetrating the skin. These qualities are essential in their native wet, windy area of south-western Scotland. The most common colour is black, but in recent years other colour types have become increasingly popular. Within the main Galloway breed a few dun animals are found. All the varieties are the same except for the colour pattern. The Belted Galloway has a white belt encircling the body between the shoulders and hips, and the White Galloway is white except for its black or red ears, nose and feet.

Kyloe or **Highland** 326kg (nearly 6½cwt); found in Highland Scotland. Extremely hardy. Dun.

Galloway 415kg (about 8cwt); found in SW Scotland. One of the oldest beef breeds. Most commonly black.

Shetland 330kg (6cwt); found in Shetland Isles. Good milk yield and well flavoured beef. Black and white.

Left: The aptly named wasp beetle (*Clytus arietus*) is frequently seen in gardens during May and June.



Above: **Timberman** (*Acanthocinus aedilis*). 13-20mm ($\frac{1}{2}$-$\frac{3}{4}$in) long. Male's antennae four times body length. Female's twice body length.

Above: *Saperda carcharias*. Measures up to 3cm ($1\frac{1}{4}$in) long. Found on poplars, July to September.

WOOD-DWELLING LONGHORN BEETLES

Longhorn beetles–so-named because of their long antennae–include some of our most attractive and colourful species of beetle. However, the wood-dwelling, grub-like larvae of certain species, found in living as well as in rotten wood, can cause considerable damage in forests, and even in the home.

Above: Musk beetle (*Aromia moschata*). 2-3cm ($\frac{3}{4}$-$1\frac{1}{4}$in) long. Found on willows, June to September.

Above: *Rhagium mordax*. Measures up to 18mm ($\frac{3}{4}$in) long. Found on oak during the summer months.

Longhorn or timber beetles are attractive insects, often with brightly patterned wing cases. They belong to the family Cerambycidae, which is mainly a large tropical group, but about 65 species–some very rare–manage to survive in Britain.

Longhorns are rather long, narrow beetles, but broader at the shoulders, with longish legs. Their antennae, at least two-thirds as long as the body, can be flexed backwards, an important feature when the beetles are flying.

Longhorn lifestyle Female longhorns lay their eggs in cracks deep in the bark of trees, and often seal them in with a quick-drying, viscous fluid. The larvae, which hatch two or three weeks later, are whitish and cylindrical. They are equipped with strong jaws with which they eat their way into wood, both dead and living, making large tunnels.

Most larvae live in the wood for two to three years before pupating in a cell near the surface. Some may take much longer, and beetles have been recorded emerging from wood that was made up into furniture as much as 20 years previously. Some of our very rare species may not in fact be native, but casually introduced in imported timber in the past.

The adult beetles are thought to feed on nectar and they can often be found on flowers such as umbellifers, particularly near woodland. Other species feed on the leaves of their host trees.

Ferocious tanner Our largest species of longhorn is the tanner, so-named because of the leathery appearance of its elytra. It measures up to 4cm (1½in) long and although not common, can still be found in such older woodlands in southern England as Epping Forest and the New Forest.

Unlike many of the other species, the tanner is out and about at dusk and swarms of 30 to 40 males have been seen flying on sultry evenings in July and August. During the day, you can sometimes find them at rest on tree trunks. If molested, and also while mating, they stridulate loudly by rasping two parts of the thorax together, a sound that can be heard some yards away. The males fight ferociously, and may bite off each others' legs and antennae.

The female tanner lays her eggs in batches deep in bark crevices or on exposed roots. Oak is the preferred host, but almost any large tree – broad-leaved or coniferous – is attacked. Even telegraph poles are sometimes chosen. At first the larvae feed just below the bark, but after two or three moults they bore deeper into the underground roots, where they remain for the rest of their three to four year larval life.

A full grown larva may be as much as 7 .5cm (3in) long, with excrescences along its length that enable it to get a grip on the tunnel walls as it moves along. It may moult up to 12 times in its larval life, before emerging from the roots in June or July to make a pupal chamber 2-8cm (1-3in) below the soil surface. The adult beetles emerge in July or August, making conspicuous holes in the soil around the tree base.

Longhorn with spots A much commoner and smaller species, the spotted longhorn is prettily marked. It flies readily in sunshine and may not be immediately recognised as a beetle. The elytra are yellow with black spots and bands and the antennae are about three-quarters of the body length and, like the legs, are black and yellow.

This species lays eggs in damp, decaying tree stumps and logs of such trees as birch, oak, beech, willow and poplar. The larvae, which reach a length of 2.5cm (1in) when full grown, live mainly in meandering tunnels deep in the sapwood for two or three years. They then bore outwards and construct a pupal cell in the spring in the outer sapwood, from which the adult can easily escape.

Common species A brownish beetle covered with patches of greyish hairs and with two pale bands across the elytra, *Rhagium bifasciatum* is one of our commonest species. It reaches up to 18mm (¾in) in length, and lives wherever suitable moist, decaying logs and stumps can be found, although it prefers to breed in Scots pine. However, larvae have been found in other conifers and also in a wide variety of broad-leaved tree stumps. They live in long galleries deep in the sapwood for two years, before pupating in the summer. After about a month, the pupa changes into an adult beetle, but does not emerge from the wood until the following spring or summer.

Rhagium mordax is another common species with a similar life-history, but it chooses oak stumps for breeding. It has a distinctive black eye-like marking, surrounded by yellow, on each elytron.

Colourful longhorns The wasp-beetle is a rather smaller longhorn, measuring up to 14mm (⅝in) long. It is black with reddish legs and yellow-banded elytra which give it a wasp-like appearance, an illusion strengthened by its jerky movements and readiness to take to flight.

Common all over the British Isles, it is frequently seen in gardens in May and June on fences and flowers. The larvae live for one to two years in a wide variety of dead trees, dry branches, posts and rustic poles, spending the first half of their lives beneath the bark before tunnelling into the sapwood.

The iridescent green, blue or coppery musk

Above: The last few segments of the female longhorn beetle's abdomen are tubular and retractile and function as a simple ovipositor. She usually lays her eggs singly deep in cracks in bark and often seals them in with a quick-drying viscous fluid. However, the female tanner (*Prionus coriarius*), shown here, lays her 180 eggs in batches of about ten. Longhorn beetle eggs take two or three weeks to hatch.

Below: You can often find the spotted longhorn (*Strangalia maculata*) in July and August on flowers – especially umbellifers – alongside woods and in roadside hedges. The hind tibiae of the male have tooth-like projections, presumably used in mating.

Above: *Rhagium bifasciatum* is said to be the most widely distributed of all longhorn species. It can be found all over England, Scotland, Wales and Ireland, wherever suitable moist, decaying logs and stumps are found. This female is laying her eggs in rotten alder.

Left: The attractively marked *Saperda populnea* reaches a maximum size of 15mm ($\frac{3}{8}$in) and has five dense, hairy yellow patches on each elytron. The female lays her eggs singly in the bark of twigs or the thin stems of poplar bushes and saplings. The larvae produce conspicuous swellings or galls in which they feed until ready to pupate the following spring. The adult beetles emerge about one month later, in June.

beetle is another attractive species which was, at one time, not uncommon throughout the British Isles. Normally found around old willows, where the larvae feed for three to four years, it is now much rarer. If you are lucky enough to find a colony you will be aware at some distance away of the pleasant, musk-like odour which the beetle produces from its thoracic glands.

Another uncommon species, found in poplar plantations in England and Scotland, is *Saperda carcharias*, a black beetle covered all over with dense, short, yellowish hairs. The adult beetles damage the poplar leaves by eating holes in them, while the larvae make large tunnels in the solid wood of living trees.

The smaller and commoner *Saperda populnea* is one of the few longhorns with an annual life-cycle. It also lives on poplar, the larvae producing conspicuous galls in which they live until they pupate in chambers excavated nearby. The adult beetles emerge in the June after the eggs were laid.

Long-antennaed timberman The timberman, a brown beetle with indistinct markings, has the longest antennae of any British longhorn. They stream behind its body when the beetle flies in the woodland sunshine, and when it settles on pine logs, the antennae reach out in front like a pair of the callipers used by wood-cutters, hence the common name 'timberman'.

The larvae feed under the bark of pine logs and have an unusual appearance when they pupate. The abdomen of the pupa is constricted at the end and the long antennae are looped backwards and forwards beneath the body.

For a long time this species was found only in parts of Scotland and Northern Ireland. Most of the records refer to specimens that have emerged from imported timber, especially pit props, and as it has now started to appear in parts of England as well it is possible that the original specimens of the timberman may well have been introduced in imported timber.

An indoor longhorn beetle

The house longhorn is unusual among longhorn species in that it attacks dry softwood in lofts of houses. Originally a European insect, it has been introduced to many countries throughout the world. It is not clear whether it is native in Britain or was introduced, perhaps in boxes or crates.

The adult beetle is blackish in colour, with two patches of grey hair on its elytra. Nowadays it breeds mainly in houses because, unlike most other species, it lays eggs directly in cracks in the wood—which does not need to be bark-covered. The larvae feed mainly in sapwood for three to four years, and their jaws can sometimes be heard rasping the wood during the warm summer weather. They can reduce loft timbers to thin shells filled with larval droppings, greatly reducing the load-bearing capacity of the beams.

Above: **House longhorn** (*Hylotrupes bajulus*), 10-20mm ($\frac{2}{5}$-$\frac{3}{4}$in long). Adults nocturnal, larvae tunnel in dry timbers. Rare outdoors.

The larvae pupate in May when they are 3cm ($1\frac{1}{4}$in) long, and the beetles emerge during July to September from large, oval exit holes as much as 10mm ($\frac{3}{8}$in) across. A new infestation is not very obvious until these holes appear, and by that time much damage will have been done. The beetles fly actively in warm weather, and can spread from house to house. At present they are confined to parts of Surrey, where the summer temperatures are favourable. However, a constant watch is necessary to prevent these destructive insect household pests from extending their range further to other parts of Britain.

A LOOK AT TREE CLASSIFICATION

The botanical names of trees tell us a great deal about how different species, and groups of species, are related to each other, and they also help us understand how trees have evolved from ancestral species over millions of years.

Above: The diversity of trees is clear enough even from a distance – the broad-leaved species in the foreground here look quite different from the upright conifers planted behind. Close to, a look at the leaves, flowers and fruits reveals more significant differences, both between conifers and broad-leaved trees and between different species in each group. These similarities and differences are recognised in our modern system of tree classification.

Plants are vital to man's needs. He has always relied on them to supply him with food and they have long provided him with timber for building and burning, and for a whole range of products, including paper, drugs, chemicals, oils and so on. The list is almost endless.

Because of their importance, man must early on have learned to name different plants so that he could recognise them quickly and distinguish them from one another. He would also have learned to classify plants as herbs, shrubs or trees and then he would have begun to group together plants that seemed similar under some general name, such as 'rose' or 'oak'.

This rudimentary grouping together of plants was the beginning of classification – a process that is essential when we think of just how many different plants there are in the world: for flowering plants and gymnosperms (conifers) the number is probably greater than 300,000 species.

However, the naming of trees was for long a haphazard affair. For example, the English, the sessile and the holm oaks were all correctly regarded as being closely related to each other because they all bear similar fruits – acorns. Hence, they were all called oaks. On the other hand, the sweet chestnut and the horse chestnut were also thought to be closely related because of their fruits. Yet today they are classified as belonging to quite different families.

Obviously, common names are not accurate enough for scientific purposes, and they are also too parochial for the international scientific community. To get round this problem Latin was adopted for naming trees (and all other plants and animals) since it was familiar to most scientists and understood by people of different nationalities. And the naming was given scientific precision by a set of rules that made it possible to fix the names of all living organisms.

Scientific classification These rules were first laid down in the 18th century by the Swedish botanist, Carl von Linné (more often called Linnaeus). He invented the principle of

using two Latin words to name a species. The first is the generic name (genus) which, when combined with the second specific (species) name, gives a unique identity to each species and a clue to its relationships. Closely related species are given the same generic name but different specific names. For example, the Norway spruce is *Picea abies* and the closely related Colorado spruce is *Picea pungens*. All the species with the same generic name are said to belong to the same genus (plural genera), in this case *Picea*.

The process of classification does not end with all the different species being placed in the appropriate genera. In a similar manner, groups of genera can be combined into a higher category called a family, which in turn can be combined into even higher groups called orders, and so on to give a hierarchy of groups. To understand more about this hierarchy, it helps to look at evolution.

Evolution To justify the hierarchical system of classification, biologists assume that all the diverse organisms we see today evolved from a single common ancestor millions of years ago by a series of divisions. At each division, new species were formed which had characters different from those of their parents. Today, we have many different species showing varying degrees of relationship between each other, more closely related species having more recent ancestors than

Right: Many families contain both trees and herbs. An example is the Rosaceae, a huge family numbering some 2000 species, among which are included some familiar trees: apple, pear, cherry, whitebeam, rowan and hawthorn. All members are distinguished principally by details of flower structure, but in the case of the hawthorn the relationship is clearly seen in the fruits (shown here) which, superficially, are distinctly hip-like in shape.

Left: Sitka spruce (*Picea sitchensis*) with young female cones. Though similar to the Scots pine (*Pinus sylvestris*), shown right, in that both are conifers, the Sitka spruce is clearly very different in its leaves. Sitka spruce leaves are short, stiff and attached singly to the shoot, while on a pine they are usually much longer, more flexible and attached to the shoot in bundles, in this case pairs. The cones, both young and mature, are also noticeably different.

A close look at the beech family

How do we decide which two among the oak, the sweet chestnut and the beech are most closely related to one another? All are classified in the same family because they have many characters in common – the flowers are catkins, the fruit consists of one or more seeds partly or wholly enclosed in a casing, and so on. However, a closer look at the characters shows that the sweet chestnut and the beech have more characters in common with each other than either have with the oak. The branching diagrams show that the sweet chestnut and the beech have five characters in common (1, 4, 5, 6 and 7), whereas the oak and beech have only two in common (1 and 2) and the oak and the sweet chestnut also have only two in common (1 and 3). Therefore, the branching diagram on the far left best fits the facts and so is the one accepted as nearest the truth.

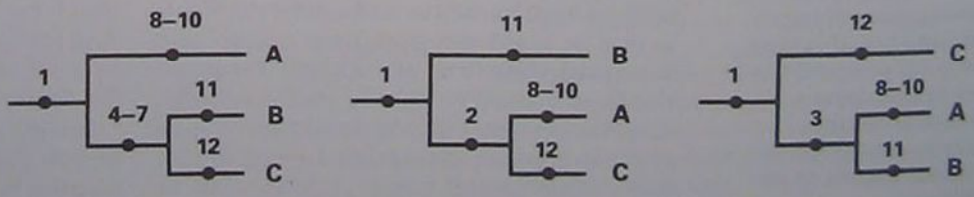
Above: An examination of the flowers and fruits of the three species shows many of the characters listed in the table, particularly points 3, 4, 5 and 8.

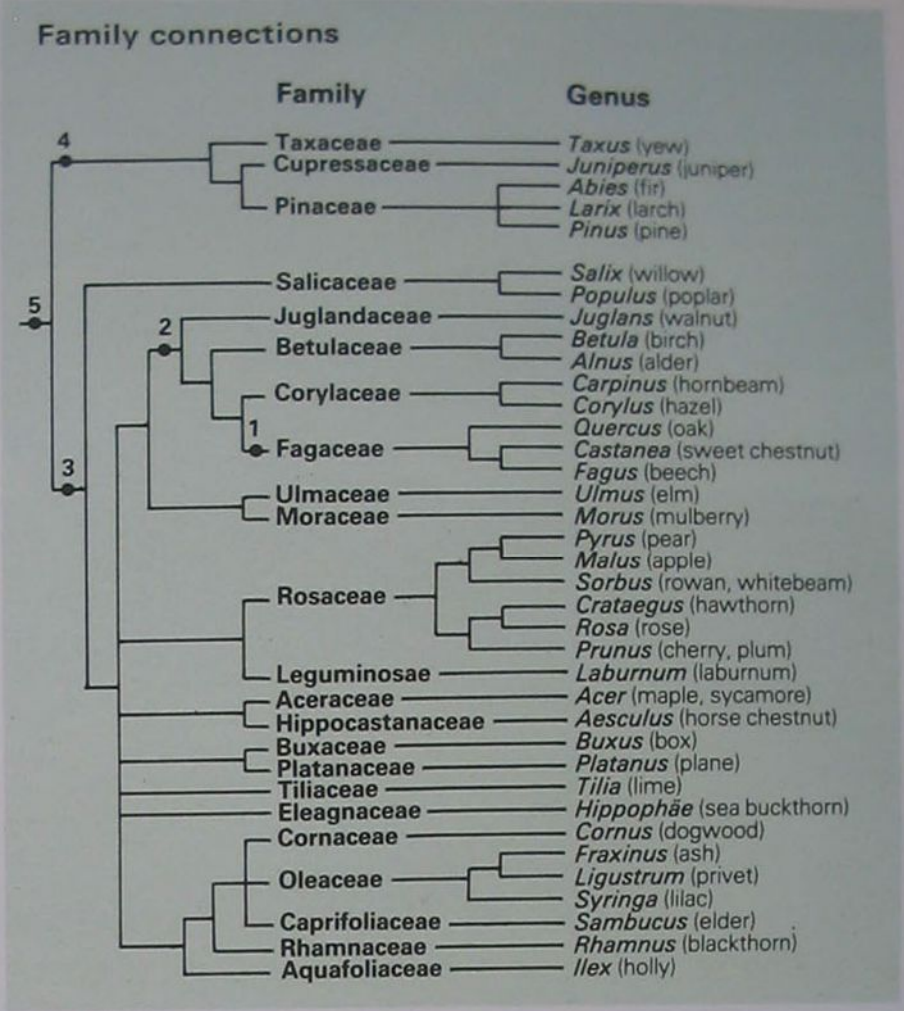
Table of characters

1	Male flowers in catkins	**A**	**B**	**C**
2	Male flowers flexuous	**A**		**C**
3	Male flowers spike-like	**A**	**B**	
4	Fruit cupules 4-lobed		**B**	**C**
5	Seeds enclosed in fruits		**B**	**C**
6	2–3 seeds in the fruits		**B**	**C**
7	Seeds angular		**B**	**C**
8	Fruits cup-like	**A**		
9	1 seed in fruits	**A**		
10	Seeds round	**A**		
11	Male catkins rigid		**B**	
12	Male catkins hang in clusters			**C**

A Oak B Sweet chestnut C Beech

Below: Of the three possible branching diagrams that can be drawn for the oak, sweet chestnut and beech, the one on the far left fits the table best.





Above: A table of the more common British trees and shrubs, showing how the different genera are grouped in families, and how these in turn are related to each other. This type of diagram is called a branching diagram or a tree diagram. It can be taken to represent more than just the relationship between genera and families. Since biologists assume that species closely related to each other shared a recent common ancestor, it follows that a tree diagram can be taken to represent the course of evolution of trees to our modern diversity of species.

those that are more distantly related.

All this can be represented on what is known as a branching diagram or (rather confusingly in this case) as a tree diagram. Species with primitive characters appear close to the central 'trunk' of the tree while those with more recently evolved characters appear higher up in the branches.

Characters and relationships To see how a tree diagram works, consider the beech family. The diagram shows that it contains three British genera: oak, sweet chestnut and beech. All are classified as being in the same family because they have so many characters in common. But of these three, which two are more closely related to each other? To decide this, we can look at each tree's characters. If two species share the same characters, it can be assumed that they came from an ancestor not shared by the third species. In this case, the beech and the sweet chestnut have more characters in common with each other than either have with the oak, therefore it can be assumed that they inherited these features from a common ancestor not shared by the oak. Hence the forking pattern shown in the tree diagram (point 1).

It is possible to recognise groups of families. Thus the beech family (Fagaceae) can be combined with the hazel family (Corylaceae), the birch family (Betulaceae) and the walnut family (Juglandaceae) because they all bear catkins. This large group of trees forms a super-order, the Hammelidinae (point 2).

Other groups can be identified among all the other families of broad-leaved trees, though the reasons are often obscure to the layman. For example, the rose family (Rosaceae) and the legume family (Leguminosae) are combined because the seeds lack an endosperm (a separate food store), the leaves bear stipules, and so on. Eventually all the broad-leaved families combine to form the subclass Angiospermae (point 3).

Branching diagrams can also be drawn for conifer trees. The largest genus here is the pines, *Pinus*, characterised most obviously by the fact that their needles are modified branches occurring in bunches of two, three or five. The pines, larches and firs form a large family, the Pinaceae, which, with the other conifer families, forms the subclass Pinidae (point 3). The Pinidae and the Angiospermae join to form the class Pinitae (point 5), which then forms a larger group with all the other green plants.

Disagreements With so much information to be considered, it is not surprising that there are major disagreements among biologists about how species should be classified: some biologists now think that evolutionary ideas of relationships cannot be included in a classification scheme. The arguments rage on, and there has not been such bad temper in biology since 130 years ago, when Darwin first enunciated his theory of evolution.

Dipper (*Cinclus cinclus*) seen mainly beside fast, stony streams in upland areas; solitary dweller. Resident. Sexes look alike. Length 18cm (7in).

Below: The dipper is found in areas between 320 and 640m (1000-2000ft) above sea level; but in the north, in places where hills descend steeply to the sea, dippers nest close to the shore as well.

DIPPERS: HUNTERS IN THE RUSHING STREAM

Dippers nest beside fast-flowing streams and flit low over the water, alighting on favoured stones and boulders. They stand bobbing and bowing for a while, and then plunge into the rushing water to hunt aquatic creatures–they even walk beneath the surface, gripping the stream bed with their powerful claws.

With its bold plumage and strong association with rivers and streams, the dipper is normally an easy bird to identify. Perhaps best likened to a 'thrush-sized wren', it has a jaunty, tail-cocked posture, and as it stands on some stone or boulder it frequently bobs up and down. Its legs are strong and look similar to those of a starling, while its beak is like that of a thrush in both colour and size. The upperparts are a rich, plain-chocolate brown, and the wings and tail look short in proportion to the distinctly plump body. By far the most conspicuous feature is the large, strikingly white 'bib' extending across the throat and breast, and down on to the belly.

In the case of English and most Scottish-breeding birds, this white bib has a broad chestnut margin which merges gradually into the near-black of the flanks and belly. Irish-breeding dippers (and also those in the Hebrides) have considerably less chestnut, and birds of the Continental race (which sometime stray to east and south-east England in spring and autumn) have almost no chestnut at all. The Continental race of dipper is in fact known as the black-bellied dipper.

Stony stream dwellers Just as characteristic as the plumage is the habitat of the dipper. Apart from stray migrants, which are sometimes seen on the coast or on slow-moving

streams in the lowlands, dippers are typically birds of fast-flowing streams and the shallow rocky shores of lochs and tarns in hilly or mountainous country. In Britain, only those dippers that inhabit the south-eastern edge of the breeding range (roughly along a line from Swanage in Dorset to Flamborough Head in Humberside) frequent slower-moving lowland rivers or streams. These birds usually favour stretches near weirs or sluices, where the water flow is broken.

Most dippers are sedentary birds, establishing a territory on a suitable stream or river and rarely straying far from it. Those in the far north, or at higher altitudes, do descend to lower waters during the winter, but in general, severe winters (especially those with a sudden, rapid-freezing onset) are fatal for many dippers.

Dippers are usually to be seen singly or in pairs (except when they have newly fledged young), and most pairs maintain their territories through the winter months. They are reluctant to cross the 'border' with adjacent territories, and double back when reaching this invisible line. Usually their flight is low and fast, with frequent, penetrating 'zit . . . zit . . . zit' calls, generally over their home reach of water; occasionally, if alarmed, they fly overland.

Not only do they have a 'home reach' of water, but also a number of favoured boulders within this, from which they hunt. These are often in mid-stream, and the dipper stands on them, bobbing up and down continuously. Against the background of broken white water, the clear white bib offers surprisingly good camouflage. As the dipper bobs and dips its tail, it also blinks, using its so-called 'third eye lid' or nictitating membrane, which travels fore-and-aft, rather than up and down, to wipe the eye surface clean. In the dipper, the nictitating membrane is conspicuously white. Under water, this membrane is thought to protect the dipper's eye from gritty particles; when submerged it becomes transparent and does not hamper the bird's underwater vision.

Underwater hunter From the boulders in its stream, the dipper hunts, often beneath the surface but occasionally just 'up to its waist' in the shallows. To submerge, the dipper may jump straight into deep water, or gradually walk into the stream until lost from sight. Once beneath the surface, it hunts on foot, and this is where the disproportionately stout legs and powerful, sharp-clawed feet serve a vital purpose in holding the bird's buoyant body down on the stream bed. Under water, the wings are used like the fins of a fish, both for propulsion and to maintain balance in strong currents–sometimes dippers swim for considerable distances.

Above: The dipper's nest is dome-shaped and built of grasses and mosses. Many dippers nest behind waterfalls, and nowadays in man-made sites such as mills, weirs or under bridges.

Below: In lowland territories, two broods a year are usual, the first eggs being laid in early March. In the Scottish Highlands, laying is up to a fortnight later, and often only one brood is raised.

Most small underwater animals form part of the dipper's diet at some stage, but favourite items include caddisfly larvae (in their 'portable homes' of tiny fragments of shell, stone and vegetation) and water-beetle larvae; worms and small shellfish; freshwater shrimps; the occasional small fish; and, in season, tadpoles.

The breeding season This begins early in the year. The tunefully sweet, if slightly disjointed, warbling song can be heard in the territories from October onwards through the winter, until towards the end of the nesting period in the subsequent June. Both sexes indulge in song with equal enthusiasm: yet another colourful feature of this attractive waterside bird.

Above: The brown honeycomb-like structures on this rock may look dead but they were built by and house a colony of sedentary polychaetes not surprisingly known as honeycomb worms (*Sabellaria alveolata*). As the tide comes in and covers the rock, these tiny worms emerge from holes in the honeycomb to catch food particles being carried in by the tide. When the tide recedes the worms retire and block up their holes to stop themselves drying out. This rock in Widemouth Bay, Cornwall, is also host to a great many mussels and barnacles.

SEA-WORMS: BUILDERS AND BURROWERS

Most marine worms lead fairly sedentary lives. Some crawl into the sand on the sea-bed or the lower shore in search of new sources of food; others build tubes in the sand or on a rock, where they hide and send out bundles of delicate tentacles to catch any food particles drifting by.

Of the thousands of different worms to be found in the sea, the most highly evolved belong to a group called the polychaete worms or bristle worms, so-named because they bear large numbers of long bristles, or chaetae. Some members of this group are free-living and predatory but the majority lead fairly sedentary lives inside burrows or tubes, which they build to provide themselves with some protection from predators.

Like their free-living relatives, the sedentary bristle worms have segmented bodies, each segment bearing a pair of appendages called parapodia. But, whereas in the former group the parapodia are large and used for swimming, in the latter group they are

generally smaller and used for burrow-building, creating feeding currents or moving along their tubes.

The two groups also differ in the development of their sensory structures. Since they move much less, the sedentary worms have no need of such efficient organs as those on the free-living polychaetes and so have fewer palps, antennae and tentacle cirri. But they are equipped with rudimentary eyes, allowing them to detect changes in light intensity.

Reproduction in the sedentary polychaetes is similar to that of their free-living counterparts except that, since they cannot swim, they cannot form swarms in the sea prior to spawning. The eggs and sperm are shed directly into the sea (the sexes cometimes doing this synchronously). In most cases, fertilisation leads to a planktonic larva which eventually settles on the sea-bed.

Instead of actively hunting food like their free-living relatives, sedentary polychaetes have devised several ways of collecting food, notably by burrowing into the substrate, feeding on accumulated detritus lying on the sea-bed or catching food particles passing by.

Burrowing lug worms The burrowing method is exemplified by one of the most common sedentary marine worms to be found around British coasts: the lug worm (*Arenicola marina*), a familiar animal to sea-anglers, who often dig them up from sand and use them as bait.

The lug worm lives in a U-shaped burrow that it digs in the sand on the middle shore down to shallow waters. It feeds directly on the sand by taking it into its mouth, digesting any suitable organic matter present and then voiding the rest. The ejected sand piles up on the surface outside the burrow, where it forms the familiar worm cast.

The body of a lug worm is ideally suited for burrowing. When it begins burrowing a new hole, the lug worm inserts its head-end (which conveniently tapers to a near point) into the sand and everts its proboscis. Once it has started digging the lug worm sends waves of contractions and relaxations along its body, using the body-wall muscles, and so pulls itself beneath the sand. After the

Above: A peacock worm with its fan of tentacles out for feeding and breathing. It builds a smooth-sided tube up to 25cm (10in) long.

Left: *Spirobis borealis* builds small, tightly coiled tubes on rocks and seaweeds. Here it is growing on a piece of bladder wrack.

Below: Some sedentary polychaetes hide from predators by burrowing into the sand; others build tubes, either in the sand or on rocks.

Below: *Amphitrite johnstoni* burrows into sand or mud from the lower shore downwards. Length to 25cm (10in).

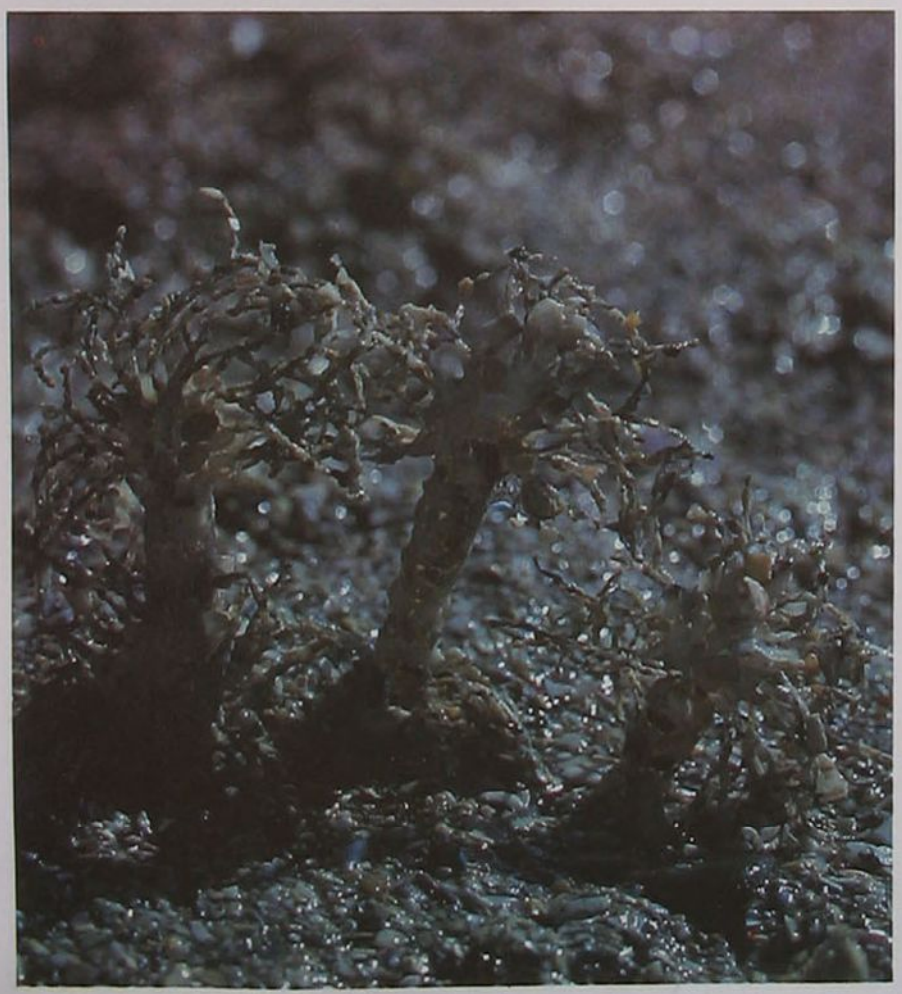
Below: The parchment worm (*Chaetopterus variopedatus*) builds a U-shaped leathery tube in sand. Length to 25cm (10in).

Above: *Sabellaria alveolata* colonizes rocks and shells, forming a network of honeycomb-like tubes. An individual (see inset) grows to a length of 4cm (1½in).

Above: Lug worms can be found burrowing into sand from the middle shore downwards. They grow up to 20cm (8in) long and have distinctive red gills in the middle of their bodies.

Left: As a lug worm digs it ingests sand, absorbs the food content and deposits the remains on the surface as a cast.

Below: Some typically ragged-looking sand mason tubes with tentacles, exposed at low tide.



burrow has been built, the lug worm lines it with mucus to keep the walls intact.

Food-catching tentacles Most sedentary polychaetes feed on food particles lying on the sea-bed or drifting past on a current. Members of one family, the Terebellidae, have long stickly tentacles, which are spread out on the sea-bed while the worm itself lies horizontally in a burrow. As particles of detritus rain down on the sea-bed, some are caught by the tentacles and passed towards the mouth by cilia. Particles already settled on the sea-bed can also be gathered.

One of the most common members of the terebellid family is the sand mason (*Lanice conchilega*). This species lives in a tube built from grains of sand stuck together by a glue secreted by the worm. Most of the tube lies below the sand but the tip projects out and supports the frail tentacles.

The tip of a sand mason's tube always looks frayed and tatty. In contrast, another tube-dwelling species, the peacock worm (*Sabella pavonina*), builds a very smooth-sided tube since it usually lives among fine sand. In some worms, including the peacock worm, the tentacles are actually the animal's gills, arranged in a fan. As water is drawn in to the centre of the fan it passes through the gills which absorb oxygen and capture food. The tentacles usually carry a number of eyespots that can detect shadow movements.

One of the strangest-looking polychaetes is the parchment worm (*Chaetopterus variopedatus*), so-called after its leathery tube. This species lives on suspended food particles, but it does not gather them with tentacles. Instead, it strains water through a mucus sac which it secretes inside its tube. When the sac is full of food, the worm eats it and secretes a new empty one, so conserving its mucus. The parapodia of the parchment worm have become oddly adapted to this way of life. Some have become adapted to holding on to the mucus bag, while three pairs have become greatly enlarged and fan-like to pump water through the sac.

Rock-dwelling species Not all sedentary polychaetes live in sand. Many species live on rocks or in the crevices between them. The most noticeable among this group are the species that build white chalky tubes on the surface of the rocks. The commonest of these is *Pomatoceros triqueter*, which builds white tubes about 5cm (2in) long and triangular in cross-section. It is often found on rocks, pebbles and shells near the low water line. Closely related is *Spirobis borealis*, which builds much smaller, tightly coiled tubes on rocks and weeds. Both worms are members of the family Serpulidae and have a crown of gills with which they feed and breathe, rather in the manner of the peacock worm.

A quite different species is the honeycomb worm (*Sabellaria alveolata*). This forms large networks of honeycomb-like tubes, inside which live colonies of worms.

A PEAT-BOG NATURE TRAIL

Well-preserved examples of the kind of peat deposits called raised bogs (or mires), once common in the British Isles, have disappeared almost entirely. But near the Welsh town of Tregaron there are three raised bogs, the largest being almost untouched.

Below: A view over peat and pools in Cors Caron. For a permit to visit, and more information, apply to the NCC Warden: John Davis, Minawel, Ffair Rhos, Ystrad Meurig, Dyfed. Telephone (097 45) 671.

What is a raised bog? It is so-called from the profile of its surface: being visibly higher in the centre than at the edges, it has the domed shape of a convex lens. Since this type of bog typically lies in a saucer of clay, it dips down into the saucer and is therefore also convex on its underside. Thus, a raised bog may be many metres deep in the centre. Although raised bogs are still widespread on high moorlands, large unspoilt areas of peat are becoming rare in lowland or semi-upland Britain because of drainage and exploitation.

Tregaron's three raised bogs have survived for three main reasons, however: first, because they were always remote from centres of population large enough to destroy them for fuel; secondly, because draining such large mires, in the days before government grants were available, would have been prohibitively expensive and would in the end have produced only poor farming land; and thirdly, because, being in one ownership, they have long been preserved for sport. In recent years they have been safeguarded as a National Nature Reserve with the official name of Cors Caron.

The history of Cors Caron Tregaron's bogs occupy a shallow valley just over 180m (500ft) above sea level, ten miles inland from the shores of Cardigan Bay. The reserve, 15 miles (by road) south-east of Aberystwyth, is

about three miles long and just over a mile across and lies north-south along both sides of the River Teifi. From steep slopes above the east side of the reserve you can see over the varied and colourful flat-bottomed valley down which the Teifi and its sidestreams come winding, spreading out to form wide pools (flashes) here and there. You can also see, especially in winter, how the generally pale surface of the vale is patched by three large chocolate-brown areas: these are the raised bogs, darkly mantled with heather. The largest lies west, the two others east, of the river.

Occupying this part of the Teifi valley immediately after the Great Ice Age was an extensive lake whose water was rich in lime and other nutrients derived from glacial boulder clay. The lake lay on a bed of clay and was dammed behind a terminal moraine, near one end of which the town of Tregaron now stands. In the course of time the lake's outlet stream, the Teifi, gradually breached the moraine, slowly reducing the level of water. The fertile, shallow lake became more and more choked with reeds until all open water disappeared and the lake had become a fen whose half-rotted vegetation, accumulating as the plants died down every autumn, slowly formed into a considerable depth of fen peat.

Eventually a stage was reached when the fen itself disappeared. Fen water is either alkaline or neutral but as the fen surface became ever drier and firmer its larger plants produced an annual supply of decaying leaves which were out of reach of the lime-rich water below. It is the nature of leaf-decay humus to be acid; and encouraged by these sour conditions and a high rainfall (50in per year) there was now an invasion of bog mosses (sphagna) which succeeded in blanketing completely the three fens of Cors Caron. This process has continued ever since, the partly decomposed remains of the moss building up all the time into a considerable depth of acid peat, domed up over the reed-bed peat below, so forming the present raised bogs.

In order to minimise damage to the ground surface, and also to avoid disturbing wildfowl, otters, polecats and other wildlife, the NCC has established two trails to cater for the 3000 people who visit Cors Caron every year. One trail, for which no permit is needed, goes north for a mile along the track of a disused railway and ends at an observation tower. The other trail, for which a permit is required, goes a shorter distance westwards along a board walk across the south-east raised bog.

The railway trail From the old railway walk along the edge of Cors Caron you gain a wide view of the reserve and its various features, among them the domed shape of the large western bog that lies in the distance beyond the river. And nearer you can see vast spreads of purple moor-grass, always being

Above: Cotton-grass is one of the many plants you can find growing on the bogs of Cors Caron. The peat taken from these bogs consisted mainly of the stems of bog moss and the remains of heather and cotton-grass.

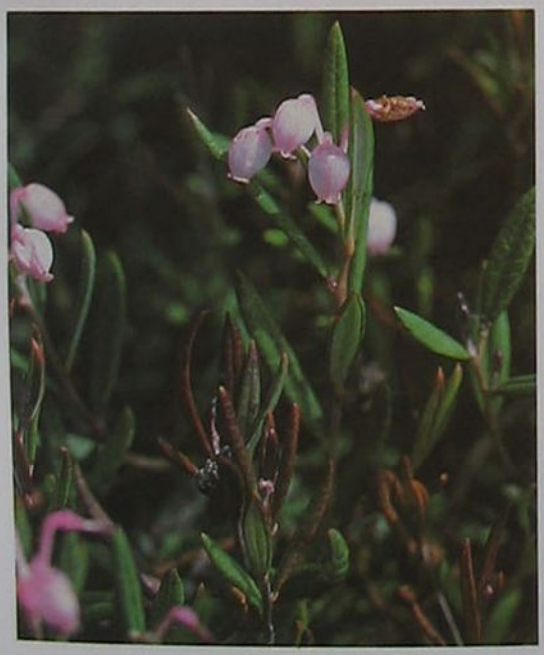
Centre left: There are few soils more vulnerable than peat. When thoroughly wet it has the consistency of blancmange and is totally destroyed by the heavy tread of gumboots. When dry it turns to dust that rises under your feet and blows away in the wind. So in peat-mire reserves extra care needs to be taken to protect the trails from damage. The best, though most expensive, solution is to construct board walks along which visitors can make their way across the bog without ever setting foot on peat or vegetation. It is true that board walks detract from the beauty and wildness of the scene, but badly eroded footpaths, getting wider and more deeply rutted year by year, look even worse.

Left: The otter is one mammal that can be found in Cors Caron. The board walks restricting visitors also help to protect this water animal from disturbance.

Right: Bog-rosemary, with its pink bell-shaped flowers, is one of the rarities that may reward a careful search on Cors Caron.

invaded by willow and birch-scrub. As you walk you may wonder how a railway could have been built across a tract of yielding peat. This was accomplished by first laying down a foundation of many bales of wool and bundles of sticks to act as a mattress on which the harder materials were laid.

The old railway, which lasted from 1866 to 1963, is raised above the level of the marshes on alien rocks, slag, cinders and lime-rich rubble brought from industrial areas, thus creating a soil quite different from the acid peat. So, along the track in summer you can expect to find a range of wild plants which enjoy well-drained, limy habitats, in sharp contrast with the bog a few yards away. Along the railway you can also see insects which are never found in the adjoining wetlands, the green hairstreak butterfly, for example. And in early spring sunshine, look out for the adders which like to bask along the track.

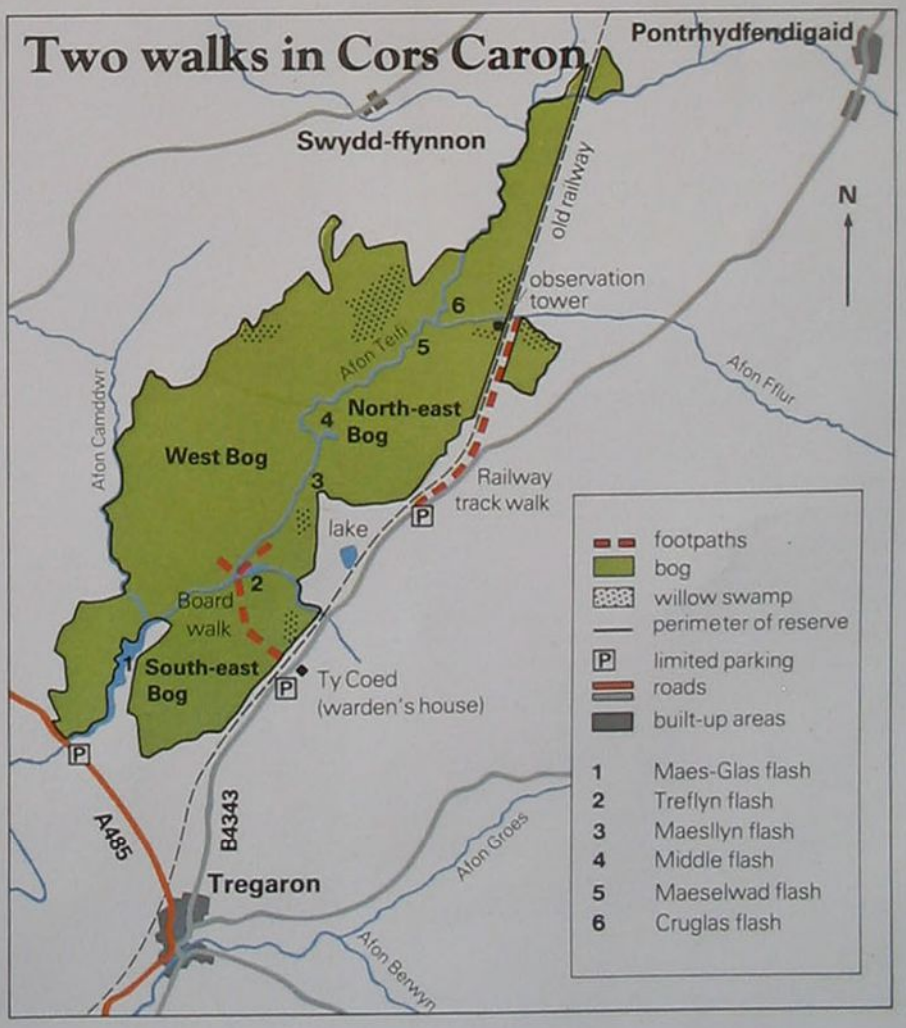


Watching birds The railway trail is the one most in favour among birdwatchers because at Cors Caron there are nearly always more species to be seen round the edges of the bog than out in the open spaces of the reserve. In fact, on the heather-covered raised bogs, bird life is extremely sparse: even in summer all you are likely to see are meadow pipits, skylarks and a few grouse. But at the margins of the bog, where there is more food and shelter, you will find many more breeding birds–for instance warblers, finches, whinchats, stonechats and reed buntings. And from the marshes between the raised bogs come the voices of black-headed gulls, curlews, lapwings, redshank and snipe.

Winter is probably a more exciting season for birdwatchers here. The observation tower is a fine vantage point from which you have a good chance of spotting red kite, hen harrier, peregrine, merlin, raven, heron, whooper swan, golden plover and various ducks. And there is always the chance of seeing a rarity, such as a bittern, white stork or goshawk.

The board walk trail If the railway route is mainly for birdwatchers, the board walk trail is for botanists. Educational parties can be taken to study peat mire ecology and conduct field experiments. A guide book based on numbered staging posts is available. Quite properly, this guide begins by warning students against the folly of stepping on to patches of bright green mosses–these are frail

Below: A map of Cors Caron —remember that you must get a permit to use the board walk trail.
Peat has the remarkable power of preserving objects from decay because it is free from bacteria. In a peat bog, therefore, valuable evidence may be found of what life was like in the past. The pollen record is particularly useful. The pollen that blows on to the bog from trees and other plants through the centuries is often preserved, becoming buried in the peat neatly in the order of time, with the most ancient at the bottom, for in an actively growing bog fresh peat is always forming at the surface and burying the older peat. By probing down into a peat-mire and then identifying the grains of pollen (the pollen of each species of plant is distinctive), botanists can find out what changes have taken place in the surrounding vegetation in the past few thousand years. Cors Caron, being so well preserved, is ideal for such investigations.



skins of vegetation covering deep, treacherous bog holes. The river is also quite perilous at times of flood (which are frequent), and there are also the adders. Most of the time you are unlikely to see an adder because they slip away as you approach, but there is a short period in spring, just after they have come out on the heaths, when they are rather lethargic and may then be stepped on.

Peat cuttings The board walk trail across the south-east bog begins with a look at one of the old peat cuttings. Here for centuries the peat was dug each summer when the water table was low, to be burnt on local hearths the following winter. Although many men (lead miners the rest of the year) were employed, they worked with spades only and so never made inroads into the deeper peat deposits near the centre of the bog. The acid peat extracted at Cors Caron consisted mainly of stems of the bog moss *Sphagnum imbricatum*. What is intriguing is that this species of bog moss no longer grows in Cors Caron and has also died out on many bogs elsewhere in Britain in the past century. No one knows why.

The river and the rand Beyond the peat cuttings you cross the Teifi on a footbridge and can see more clearly than ever how far the stream's narrow, rushy flood plain lies below the level of the raised bogs on either side. The river is fringed with tall plants which like their roots to be in water, one of the most conspicuous being the reed-grass *Phalaris arundinacea*. In the river itself there are long streaming stems of water-crowfoot and pondweed, and submerged forests of water-milfoil, water-starwort and yellow water-lily–all hospitable cover for invertebrate life and for the trout and the many splendid salmon that come to spawn in autumn.

From the footbridge the walk takes you up the slope, called 'the rand' by ecologists, to a shoulder of the western raised bog. Here there has been no peat cutting and the original rand vegetation is intact. Amid a great deal of purple moor-grass you can find tormentil, bilberry, cowberry, bog asphodel, deergrass, round-leaved sundew and also the very local bog-rosemary with pale pink, bell-like flowers, a speciality of bogs in the west and north of Britain. White beak-sedge is abundant just here, so if you go in July look out for the rare large heath butterfly whose caterpillars feed on the leaves.

Above: The common aeshna dragonfly is one insect you may well see as you cross the River Teifi on the footbridge beyond the peat cuttings of the south-east bog. Trout and salmon both frequent this river.

Below: The observation tower at the end of the railway track trail makes a fine vantage point for bird-watching. In winter you can see such birds as the hen harrier (shown here), and red kite, peregrine, merlin, and heron.

An active bog The trail now retraces its steps to the peat cuttings, then up on to the south-east bog where you can see the little mossy pools where fresh peat is still being formed. Several species of sphagna are involved in this process, which is the hall-mark of what ecologists call an 'active' bog, as distinct from one where new peat is no longer being produced. In or near these pools you may find two more kinds of sundew, the oblong-leaved and the great sundew.

On this south-east bog, if you have the right equipment, you may probe deeply into the ground to take your own peat core and so discover for yourself what lies several metres below your feet. A study area is available for such experiments.

The lagg The last major habitat to be visited is what botanists call a 'lagg'. This is an area of rather marshy ground at the edge of the reserve and is of a type often found at bog margins which feel the influence of a sweeter water draining in off adjoining slopes. In these less sour surroundings grow far more species of wild flowers than are ever found in very acid bogs–for instance wild angelica, marsh-marigold, cuckoo-flower, meadow-sweet and lesser skullcap.

HIGH-FLYING HAIRSTREAKS

The hairstreaks, among the most attractive of our butterflies, are small and swift-flying but rather fragile in appearance. As many of them fly in woodland, sometimes around the tree tops, even the more common species can be hard to spot.

Above: Although the green hairstreak (*Callophyrs rubi*) is the most common of the British hairstreaks it is perhaps the least typical of the group. It lacks the 'tails' of the hind wings and the 'hairstreak' itself is represented by a series of white dots, or may even be absent. The green coloration is limited to the underwings in both sexes, the upper wings being dark brown. The wings are fragile and become tattered after a few days of flying.

Hairstreak butterflies belong to the Lycaenidae, so are closely related to the blues and coppers, the other members of this large family. There are five British species–the black, the white-letter, brown, purple and green hairstreaks. They are usually characterised by their 'tailed' hind wings (which are highly developed in some of the exotic species), and by the hair-like streaking on the underside of their wings which gives them their common name. Their underwings are often more attractively coloured than the upper wings, especially in the case of the brown and green hairstreaks.

Restricted range The black hairstreak is locally common in only a very limited region of the English Midlands, an extreme localisation that has an interesting background. The species is widespread on the European mainland, but absent from north-west France and the Low Countries. Curiously, the transverse band of remnant forest inhabited by the black hairstreak–extending north-east from Oxford almost to the Wash–appears to be a continuation of a broader band of distribution running south-west to north-west through central Denmark and the extreme south of Sweden.

The black hairstreak is clearly on the edge of its European range in these countries and probably once occurred throughout the surrounding areas during a warmer climatic period, long ago. When the climate subsequently deteriorated, isolated populations of the black hairstreak presumably survived by adapting to the environmental conditions; it is possible that these populations were established during the latter stages of the last Ice Age.

Despite the very restricted range of the black hairstreak in Britain, its larval food plant–blackthorn–can be found growing almost everywhere. The caterpillars are usually found only in old blackthorn thickets along woodland borders and rides, and in clearings. The butterflies, which appear on the wing in June and July, feed on the flowers of dogwood and wild privet.

Elm-dwelling species The white-letter hair-

Brown hairstreak
(Thecla betulae)

Right: The male brown hairstreak is smaller than the female (above), and lacks the bold patches of orange she has on her forewings. Both sexes have tawny-orange undersides.

Above: The purple hairstreak (*Quercusia quercus*) is easily identified by its coloration but, as it generally swarms around the tops of oak trees, it is rarely seen. The blackish forewings are shot with a purple iridescence which is brighter in the female (shown here), but confined to large patches on her forewings. The amount of purple visible depends on the angle of the wings to the light, and the position of the observer.

streak is common but localised throughout most of southern England and Wales. Since 1900 its range has contracted southwards from north Yorkshire to a present day line from Cheshire to the Wash.

It is a drab butterfly, apart from the distinct white 'W' mark on each hind wing, and is generally found in woods and hedgerows where the larvae feed on species of elm – the wych elm in particular. There are fears that the ravages of Dutch elm disease will have adverse effects on its present distribution, but so far there is little clear evidence of this taking place. In June and July, the butterflies can be seen around elm trees, and visiting the blossoms of bramble, privet and buddleia for nectar, and lime for its abundant honeydew, which is also a source of nourishment.

Secretive brown hairstreak The largest of our hairstreak species, the brown hairstreak is locally plentiful over most of southern England and Wales, but rarely seen. It also occurs in Ireland where it is very rare and confined to a few localities in the south-west.

The tawny-orange undersides of both sexes of the brown hairstreak readily distinguish them from other British hairstreaks, with the possible exception of the black hairstreak which is, however, a darker orange-brown with black-spotted bands on the hind wings.

Brown hairstreaks tend to hide among blackthorn thickets (their larval foodplant), only flying when the weather is bright, and then usually high up. They can occasionally be observed feeding at the flowers of brambles and other plants in August and September – particularly in the latter month when they fly along woodland borders and thick, old hedgerows.

Oak tree dweller Purple hairstreaks are locally common wherever oaks grow, except in northern Scotland and Northern Ireland. They fly in July and August, but as they often swarm around the tops of their larval food plant, the oak, or sometimes other trees, they can be difficult to spot. When they are seen, feeding on the honeydew that accumulates on the foliage of such trees, they are easy to identify because of the purple iridescence on the blackish forewings.

Unusual hairstreak The green hairstreak is generally common throughout the British Isles and is immediately identifiable by the green colouring of its underwings. This brilliant colour – unusual among butterflies – is not due to pigmentation, but to the special structure and arrangement of the scales. Green hairstreaks are also unusual in lacking the characteristic 'tailed' hind wings of the other hairstreak species.

They are on the wing in May and June – rather earlier than the other species – and frequent a greater range of habitats, from woodland edges and scrub to downland and heathland wherever some of their food plants are present. These are numerous and include

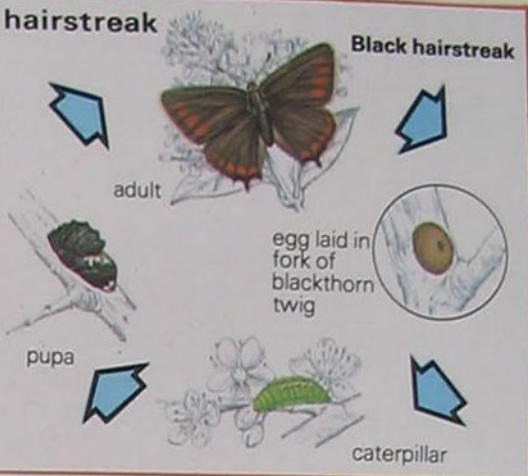
Hairstreaks with false heads

Hairstreak butterflies have evolved an ingenious device to deflect the surprise attacks of predators from their head. When they are at rest with their wings closed, the characteristic 'tails' of the hind wings, combined with the adjacent eye-like spots or markings, look remarkably like a conspicuous head with antennae and are thus more likely to attract an attack than the real head, but with less harmful results.

Some of the more exotic species may also turn around on alighting. Therefore, if a predator notices one arrive and launches an attack, it is additionally confused by its victim flying off in an unexpected direction. All British hairstreaks, save the green hairstreak, possess false heads but they are convincing to our eyes only in the purple, (right), and black hairstreaks.

Life-cycle of the black hairstreak

The adult black hairstreak (*Strymonidia pruni*), left, lays her eggs singly on the twigs of blackthorn in summer. The eggs do not hatch until the following spring, producing woodlouse-like green caterpillars which feed on blackthorn from April to June before pupating. The black and white pupae resemble bird-droppings, and the butterflies emerge after three to four weeks.



broom, gorse, dogwood, bramble, heather, bird's-foot trefoil and rock rose.

Cannibalistic caterpillars The green hairstreak is not only different in appearance from the other species, its life-cycle is also different. While the other hairstreaks hibernate in the egg-stage, the greenish eggs of the green hairstreak hatch about a week after being laid, in June or July. The resulting pale green caterpillars, striped with yellow, feed until ready to pupate in late July or early August. The entire autumn and winter is then passed in the pupal stage, lying amid the leaf litter on the surface of the ground.

After they have moulted their skins for the first time, the caterpillars of the green hairstreak are noted for their ferocious cannibalism–a characteristic they share with several other species of Lycaenid butterfly. Black hairstreak caterpillars in captivity have also proved to be cannibalistic.

Hairstreak life-cycle The other four hairstreak species spend the winter as eggs, which are deposited singly on the twigs of food plants. The eggs vary in colour, from white in the brown and purple hairstreaks, to pale brown ones which turn grey later in the case of the black hairstreak.

The full grown caterpillars, hatching in spring, resemble woodlice; they are predominantly green apart from the purple hairstreak caterpillar which is chestnut-brown. They feed on or within the buds of their food plants, later switching to the flowers or leaves when these develop. The caterpillars of the green and white-letter hairstreaks possess honey glands, the sweet secretions of which are attractive to ants who, in consequence, guard them against potential predators.

With the exception of the green hairstreak, all the caterpillars may be found feeding from April to June, before they pupate. The pupae, which are shaped like tiny, trussed chickens, are brown with darker markings (apart from the black hairstreak pupae which are black and white and resemble bird-droppings). They are generally attached to the twigs or leaves of the food plants by silken pads and girdles, although the brown hairstreak is held by the half-discarded larval skin, and the purple hairstreak often lies in oak bark crevices or on the ground among fallen leaves. Apart from the green hairstreak, which overwinters as a pupa, the butterflies usually emerge from the pupal case in three to four weeks. Late summer is the best time to look for most of the species as they fly among the woodland trees.

Above: The white-letter hairstreak (*Strymonidia w-album*) takes its name from the pronounced white 'W'-shaped streak on the underside of each hind wing. It bears a striking resemblance to the black hairstreak although this species has orange blotches on the margins of the upper wings, and a more indistinct 'W' mark. The black hairstreak is further distinguished by its lighter underwings, which may be almost orange in colour, and the row of white-edged, black spots on the inner side of the orange marginal band.

Above Left: The eggs of the white-letter are laid singly on twigs of the food plant. They are green with a white rim, the green turning brown after a few days.

PRECARIOUS SCOTTISH BIRCHES

Ancient relics of the once vast Caledonian Forest, the Birks of Aberfeldy cling to steep hillsides from where waterfalls tumble to the burn below.

Above: Silver birches predominate at the tops of the steep slopes and on the upper parts of the slopes themselves. They do not penetrate to the lower parts of the gorge where, in the cooler, more humid atmosphere, alder, ash and elm woodland take over.

Below: The red and white dotted caps of the fly agaric are a familiar sight in autumn, for they form a valuable symbiotic relationship with the roots of the birch trees.

Twelve thousand years ago, when the ice of the last glaciation finally disappeared from the Southern Grampians of Scotland, the hillsides about Aberfeldy were covered with a layer of stones, sand and gravel deposited by the melting ice sheet, and the contours of the hills and glens were gently rounded where they had been smoothed by the abrasive action of moving ice. In time the landscape became clothed with vegetation and, as the climate warmed, there occurred a succession of changes which finally resulted – between five and seven thousand years ago – in the arctic tundra-like communities giving way to forest.

The stages in the development of the forest, and its subsequent history, are known from the record of the past vegetation which we find preserved in peat deposits all over the Highlands. This evidence tells us that the dominant tree in the ancient Caledonian forest of this area was the birch, although in other places – nearby Rannoch, for instance – the dominant trees were Scots pine. Why Scots pine did not dominate in this area as it does in Rannoch (only 24km/15 miles away), is a mystery. The soil conditions appear to be suitable and so, too, is the climate. The probability is that the level of grazing by deer, hares and other animals is sufficiently high to have prevented pine regeneration but is not sufficiently severe to prevent regeneration of birch completely.

Relic woodland The Birks (Scottish for birches) of Aberfeldy is a small relic of a once vast forest. Most of the Highlands are now deforested, due to the intensive grazing of millions of sheep and to systematic burning, mainly for the maintenance of grouse moors, while elsewhere the landscape has been reforested for commercial timber production, largely with coniferous species. These pressures have modified or destroyed most of the ancient forest and made the Birks of Aberfeldy, and places like it, important as the last fragments of natural, or at least semi-natural, woodland left in Scotland.

Flowing through the Birks is the Urlar Burn. This stream has cut into the hillside forming a deep gorge with steep and precipitous sides, and herein lies the secret of the wood's survival. On slopes too steep for agriculture, in a place so dangerous for animals that sheep are fenced out, the native woods have managed to persist. The steep slopes, with their cover of free-draining glacial deposits, provide soil conditions perfect for silver birch. It prefers a dry, acidic sandy soil, unlike its close relative the downy birch which is to be found where soils are wetter and richer in mineral nutrients. Both kinds grow here in fact, but it is the silver birches, with their slender silver trunks, black and knobbly at the base, and graceful pendulous twigs, which have given the area its name.

In the parts of the wood where conditions are most suitable, the well-grown trees, about

15m (50ft) tall, are on average 50 years old. Here and there lie trees which have grown into old age and died when they were 80 to 100 years old. Often they stand a while, still covered in lichens but bearing brackets of fungi, too, before falling in winter gales. Young trees and seedlings are hard to find. It seems that regeneration of the birks is sparse at the moment and rather sporadic.

Although the Urlar Burn has cut deeply into the relatively easily eroded mica schist, there are several places where a much harder volcanic rock, dolerite, has formed veins or dykes through the hillsides. These erode more slowly than the schist and the position of each dyke is marked by a waterfall in the stream. The Moness Fall, at the upper end of the Birks, is the most spectacular of these, the stream plunging impressively to create a huge waterfall zig-zagging downwards for more than 30m (100ft), only to cascade almost immediately over the next fall. Down in these lower parts of the wood, the birches give way to mixed deciduous woodland of great diversity.

Site of Special Scientific Interest The variety of trees, and other plants, in the wood is the reason for the Birks being officially recognised as a *Site of Special Scientific Interest*. The uncommon wood vetch occurs here, as does bilberry, cowberry, crowberry and heather, and the older trees are clothed over their trunks and main branches with an almost complete cover of lichens. Hazel is also common among the birches.

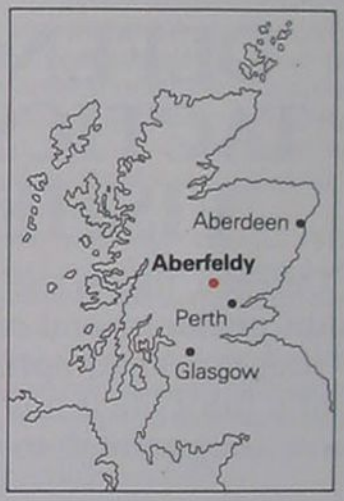
Effects of animals The wealth of ground vegetation indicates that animals are not grazing these woods in any great numbers. If there were intensive grazing, as happens in many other birchwoods in this area, the ground vegetation would be short grass instead.

Above: Birch trees growing on the hill slopes in the winter. Little natural regeneration is occurring in the wood, and most of these trees appear to be about the same age.

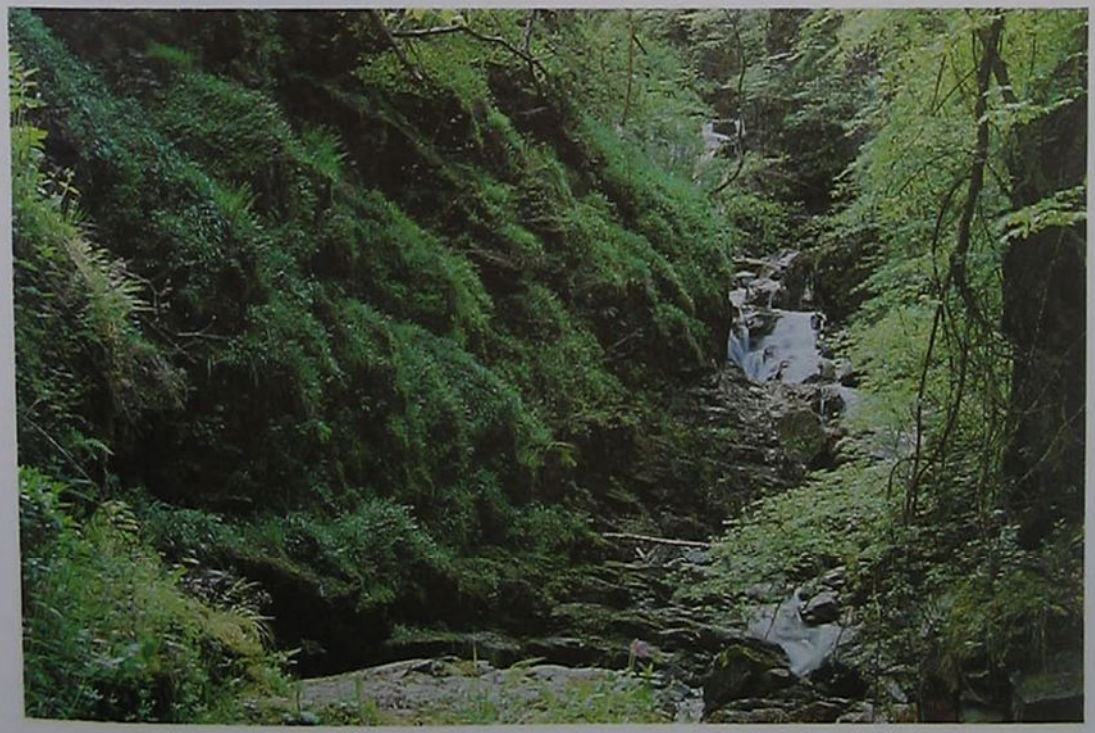
Sheep may not be able to get into the Birks, but there are other animals which do come into the woods to feed. In particular there are roe deer here and, though they seem to cause little damage to the ground vegetation, they are avid browsers and very partial indeed to young birch shoots and seedlings. Infrequently seen as they are, their effect is clear and important because in extensive areas they are preventing regeneration of young birch trees.

Furthermore, many of the trees, especially at the edge of the wood, have several stems growing from each root-stock. This could result from damage to the trees when they were young, perhaps by grazing, but more likely it is because, in the past, trees have been felled and have then produced many fresh shoots around the old stumps, a few of which survive to form flourishing full-sized stems.

However natural the Birks of Aberfeldy are in origin, it seems that there has certainly been some human interference – in the recent past at least.



Above: The Birks of Aberfeldy lie just to the south of the town itself.



Left: Middle Falls in summer, where the water from the Urlar Burn tumbles over moss-clad rocks to the valley bottom. The steep, craggy nature of the slopes, where many of the birches grow, can easily be seen here. The atmosphere of the wood, even where the trees grow densely, is light and airy, for although the trees may be in full leaf in mid-summer, the leaves are small, and plenty of sunlight penetrates the delicate canopy to produce a dappling of light and shade on the ground, enabling a ground layer to develop which is rich in plants and insect life.

DEFENCE TACTICS IN FISHES

Above: Fishes such as dace are ideally coloured for protection in the water. From above their dark backs merge with the overall colour of the water, so helping them to escape the notice of such predators as birds, while from below their silvery bellies and sides are lost against the reflections from the surface of the water.

Defence, that is the avoidance of predators and care of the young, is an important aspect of a fish's life if it is to survive long enough to breed.

The essential element in the success of any animal is its ability to survive long enough to breed and produce a new generation. In fishes, as with many other animals, the defence tactics adopted for survival are numerous and elaborate and occupy virtually the whole of their existence, often dictating their body form, colouring, perception of surroundings and their behaviour. The finding and catching of prey, avoidance of predators, keeping competitors away, surviving in the habitat and eventually finding a mate and breeding are all activities for which defence can be necessary. Some fishes take this a step further by actively protecting their eggs and young.

Defensive colouring Coloration plays an important role in helping a fish to avoid being seen – an advantage both in that it protects the fish from predators and also in that, in some cases, it permits the fish to approach its prey unseen.

In general, concealing coloration is exploited most by fishes leading a sedentary life on the sea bed – most flatfishes, angler fishes and, in rivers, such fishes as the bullhead and the eel. Many fishes which live on the shore between high and low tides are adept at changing their colours to match the background, examples being the shanny, the long-spined sea-scorpion and young corkwing wrasse. They can change their background colour to dull red if they are living among red algae, greeny brown when close to clumps of brown seaweed or rocks, and bright green when living in pale sea lettuce.

Even fishes which appear to be brilliantly coloured when they are out of water may be well-concealed by their colouring when in water. Many fishes living in open water have dark greeny brown or blue backs shading to silver on the sides and belly. Examples are dace and bleak in fresh water, herring, mackerel and blue shark in the sea. Conspicuous as they may look on land, their colouring offers protection or concealment in the water. Where the light comes from above the dark back merges with the overall colours of the water, while from below the silvery belly and sides are lost against the reflections from the sea's surface. This type of colouring is known as obliterative shading and can be seen in many aquatic and land-dwelling animals.

Schooling Many of the fishes which are obliteratively shaded live in schools, the dace, bleak, herring and mackerel being obvious examples. But school forming is not confined only to such fishes since it offers great defensive advantages.

Schooling fishes secure protection by being part of a crowd. A predator viewing an approaching school is confused by the mass of individuals which, while keeping close together, do not keep in the same position relative to one another as they swim. Singling out a suitable victim, the predator is thwarted when the intended victim's place is taken by another fish, and that by a third, producing a relay effect.

School formation imposes certain restraints on the fishes involved. They must all be capable of swimming equally well and, as swimming ability is strongly correlated with size,

Below: The vertically striped body of the perch is superbly well camouflaged for hiding motionless among reeds. As well as allowing the perch to hide from potential predators, the stripes also enable it to remain unnoticed as it hunts for food.

this is why all members of a school are the same size–little fishes form their own size schools. Likewise, disabled fishes tend to be at a disadvantage–individuals blinded by accident or parasitic infestation of the eyes fail to pick up the movements of a school as quickly as normal fishes, and as a result tend to lag behind, possibly falling victim to a predator.

Small and solitary Paradoxically, it seems that, while schooling offers protection to small fishes, so does a solitary existence. But solitary fishes are forced to adopt a low profile and to remain hidden–this is why it is a form of protection adopted by small fishes. In fresh water the stone loach and the bullhead live under stones or in dense weed beds and emerge only at night or in twilight to feed. Both are rarely longer than 9cm ($3\frac{1}{2}$in). In the sea numbers of gobies, clingfishes and blennies adopt similar habits. Not surprisingly, these fishes are also all notable for their concealing coloration.

Small size can be a positive advantage, for the species as well as for the individual. One of the most successful families of fishes in terms of numbers of species worldwide is that of the gobies–there are 18 species in British seas alone. They are small fishes, few ever growing longer than 20cm (8in). One advantage in being small is that they can exploit mini-habitats–crevices in rocks, coral or sponges–and thus be safe from many predators. Another is that sexual maturity is reached at an early age, many gobies breeding the year after they themselves hatch.

Sight and sound All these behavioural means fishes have of preserving themselves from being eaten rely on highly sensitive sensory capabilities. Fishes swimming in schools keep together by employing both sight and sound. The school retains its cohesion by visual contact, the individuals keeping their place relative to one another by an awareness of the eyes of the other fishes–the eyes being the most obvious visual reference point. But blinded fishes can usually join a school with only a slight disadvantage and must therefore get their clues as to speed and direction from changes in the water pressure made by their neighbours.

A moving mass of fishes makes a soft rustling sound in the water and it is likely that the blind fish hears this and adjusts its swimming accordingly. Its lateral line system also detects pressure changes in the water.

'Panic' protection An additional defence system, little understood, is the production of an alarm substance by certain fishes. First discovered when an experimental study showed that an injured minnow gave off a substance which resulted in the appearance of panic in the remainder of the school, it was later identified as coming from certain cells in the minnow's skin. Water in which pieces of skin from a freshly killed minnow had been soaked produced the same panic reaction in minnows, but not in other fish species.

Later studies have shown that alarm substances are present in the skin of many members of the carp family (and it can be assumed that all carp are so equipped), and some members of the perch family. Each apparently produces a reaction in its own species.

The advantage of such a defence system is that while one individual is sacrificed, the remainder of the community is alerted to danger. Its development in the carp family is particularly advantageous as carp are mainly schooling fishes, living in fresh water in which, because of sediment and plant plankton, visibility is often poor.

Spines A further defensive measure that helps fishes to survive is the development of spines in the fins and on the body. These are most remarkable in some late larval stages and serve to make the tiny fish too big for many potential predators to engulf it. Sticklebacks have long stiff spines on their backs and bellies, which can be 'locked' upright to make an inconveniently spiky mouthful.

Above: So important is the protection given by schooling that the young of many fish species form schools even though they will be solitary fishes when full-grown. The 10-spined stickleback, shown here, is a classic example for in late summer the young of that year band together in the shallows in large loose schools, yet by the next spring they will be spread out through their habitat, the males (at least) each possessing a territory.

Below: A mass of minnows at the edge of a lake. The minnow was the first fish in which a special 'alarm substance' was discovered. This substance, given off by an injured minnow, results in the appearance of panic in the other fishes and alerts them to danger.

MICE AMONG THE CORNFIELDS

Harvest mice, the world's smallest rodents, are often found among cornfields in summer, feeding on a varied diet that in times of shortage may even include each other.

The diminutive harvest mouse is difficult to observe in the wild and was not discovered by scientists until comparatively recently. The mid-18th century naturalist, Gilbert White, first recognised it in the 1760s as a distinct British species, although it had been observed in Europe some 20 years before.

The most distinctive feature of the harvest mouse is its small size, yet mouse-like rather than shrew-like appearance; however it is less mouse-like than the other British rodents, with a round blunt face, small eyes, and short hairy ears. The tail is roughly equal in length to the head and body, and has a small tuft of hairs at the tip. Adult harvest mice are russet-orange in colour, with a white underside. In winter the black-tipped guard hairs increase in number and the coat appears darker.

Lofty homes Typically the harvest mouse is found during the warmer months of the year among tall stalks of cereal crops, usually mid-way up the stem. Sometimes nests are built over standing water–harvest mice are good swimmers–but usually a dry place is preferred.

Harvest mice build two types of nest: the intricate breeding nest constructed by the female above ground, and a much more flimsy, unlined non-breeding nest built by either male or female throughout the year, above or on the ground, and seldom lasting for more than two or three weeks.

Like most mammals, harvest mice are mainly nocturnal. During summer there are peaks of activity at dusk and dawn, with several shorter periods of activity at night. They are solitary animals, each keeping to a territory of around 400 square metres in grassland. Home ranges, especially those of males, overlap, but females probably defend a small breeding area. Territories are scent-marked, urine and faeces being deposited on grass stems and on the underside of leaves.

Harvest mice are aggressive towards one another, especially in late winter and early spring when competition for food is great, and quarrels often result in the loss of parts of the tail, ears and feet of the subordinate animal.

Varied diet Harvest mice are omnivores, eating plants and animals. They feed on seeds, especially cereal grain and grass seeds, and a wide variety of fruits, shoots and insects. Occasionally they take the eggs of small birds. To get at the seeds of cereal crops the mouse grips the seed head with feet and tail. Seeds are levered out of the head with the incisor teeth, then held in the forepaws and eaten above ground. The husk is discarded, and often only part of the seed is eaten before the mouse moves to another seed. In some parts of Europe damage may be considerable, but in the British Isles it is limited, and the animals' presence may even be beneficial, for they also eat crop pests. Harvest mice eat meat when given the opportunity, whether it is the bodies of other small rodents, or each other. Cannibalism is common during winter when other food is in short supply.

Raising a family Harvest mice mate in March and April and litters are found from late April and early May. Breeding increases in intensity during summer, reaching a peak in August and September when 75% of the year's litters are born. Courtship is often aggressive, and after mating the female may turn on the male and drive him away. Before mating, the female may be chased through the tops of the vegetation by more than one male. Mating finally takes place at ground level. The male plays no further part in raising the family, and it is the female who constructs the famous breeding nest.

Working at night, the female shreds grass leaves into 15 or 20 strips with her teeth and weaves them through standing grass stems, which she has previously bitten and weakened to make positioning easier. She builds a framework from inside the nest, filling it with finely chewed grass or other materials to form the characteristic ball shape. Between three and eight young are born, and while they are

HARVEST MOUSE
(*Micromys minutus*)
Size Head and body length 5-7cm (2-2¾in); tail 5-6cm (2-2¾in); weight 5-8g.
Colour In summer russet-orange fur with black-tipped guard hairs on the back; coat becomes darker in winter. White underparts.
Breeding season May-December, reaching a peak between Aug-Sept.
Gestation 17-19 days.
No of young 3-8.
Lifespan Probably less than a year in the wild.
Food Omnivorous. A wide variety of seeds, fruits and insects. Cannibalistic, and will eat other small rodents.
Predators A wide variety of animals including birds, mammals, toads and snakes. Man, destruction of habitat, discarded bottles.
Distribution Locally common in S and E, rarer in N as far as Edinburgh.

Above: The harvest mouse is just a quarter of the weight and half the size of the wood mouse, and its skeleton is only five per cent of its total body weight. As it is so light, it balances easily on corn heads.

Right: The harvest mouse has a high metabolism and needs to eat up to 30% of its body weight daily. The food requirements of an 8g (just over ¼oz) harvest mouse are equal to that of a wood mouse weighing two and a half times as much.

developing the female mates again and builds a new nest for her next litter.

Young acrobats The young mice develop quickly and after 12 days can crawl around the outside of the nest, using their tails as additional support. They become independent at 16 days old and may be driven from the nest by their mother. At this stage the young mice are a dull brown colour and do not gain the russet adult coat until their first moult.

During their first six weeks of independence two-thirds of the mice will die and few of the survivors will live longer than six months. Their small size makes them prey to numerous animals, including some mammals, and birds. Even so, these mice are not a crucial item on any of their diets, even that of the greatest harvest mouse predator, the barn owl.

Above: The harvest mouse is well adapted for moving around easily in cornfields: it is the only British mammal with a truly prehensile tail, the last 2cm ($\frac{3}{4}$in) of which can grip stems like a fifth limb. When the mouse climbs upwards the tail is used for balance, while its strong front and hind toes grip the grass stem. The outer toes on the hind feet are opposable, like a human thumb. To descend the tail is used as a brake, gripping the stem.

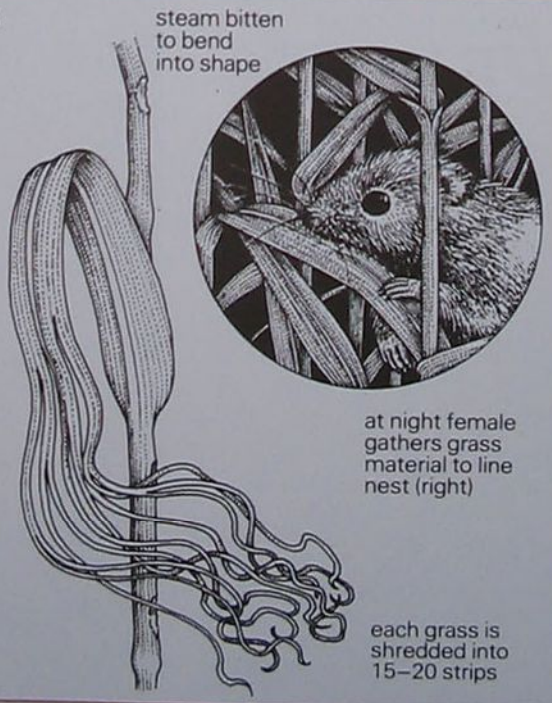
Harvest mice are sensitive to intrusions in their environment and their first reaction is to freeze until the source of the disturbance is identified. They then creep away to hide, or crash headlong to the ground in an effort to escape. Many are also killed by machines at harvest time, especially young that have not left the nest. Adults may fall prey to scavengers as they hide in the straw, or are killed when the stubble is burned. In addition, up to 80% of litters may die as a result of rain or cold.

Winter ground dweller In autumn the harvest mouse becomes a ground dweller. It sometimes moves into barns or outbuildings where it lives among stacks of bales. Often quite large congregations of mice can occur in these places, and territorial aggression is common. Other winter dwelling places are the base of a grass tussock or the disused burrow of a small mammal, where a non-breeding nest is constructed.

Harvest mice do not hibernate. They are less active during winter, but they spend more time out in daylight than they do during summer. They are protected by a thick layer of subcutaneous fat, more than is found in most small rodents. The guard hairs increase in number, but the animals do not develop a particularly thick coat. To animals so susceptible to rain and heavy dew, a dense coat of difficult-to-dry fur would be a disadvantage. They are adaptable animals and quickly take advantage of new nesting sites such as motorway verges and disused factory sites. They are probably as common today as they were a century ago, although at that time they were erroneously thought to be on the decline as a result of the introduction of harvesting machinery.

A harvest mouse nest

Gilbert White's description of a harvest mouse nest is unequalled: 'One of these nests I procured this autumn, most artificially platted, and composed of blades of wheat; perfectly round, and about the size of a cricket ball; with the aperture so ingeniously closed that there was no discovering to what part it belonged. It was so compact and well filled that it would roll across a table without being discomposed, though it contained eight little mice that were naked and blind . . . . This wonderful cradle, an elegant instance of the efforts of instinct, was found in a wheat field, suspended in the head of a thistle.'


steam bitten to bend into shape
at night female gathers grass material to line nest (right)
each grass is shredded into 15–20 strips

ALIEN PLANTS: OVERSEAS EXOTICS

Sometimes you can find unfamiliar plants growing in rather unusual places. Often these are alien species–exotic plants that have arrived here from abroad by various means, and established themselves in dockyards, around factories and on rubbish tips.

Above: Rubbish tips, like this one covered in soya bean waste, are a good place to look for alien species as refuse has the makings of a rich soil, and lack of competition encourages their growth.

Every year the number of animal and plant species found in Britain is increased by those arriving here through the agency of man. Some plant species, such as lucerne, are deliberately imported as crop plants, but a surprisingly high number of 'hitch-hikers' are introduced quite unintentionally to our shores. Animal pests like Colorado beetles must be eradicated quickly before they can spread, but many of the other animals and plants present little or no threat to our countryside.

How aliens arrive The non-native arrivals are called aliens and they are brought here by diverse means–generally arriving as seeds which, given the right conditions, germinate and grow here. Some arrive as impurities in imported seed and grain, while others are found in raw materials such as road and railway ballast, and animal fleeces.

Our food provides some of the more exotic aliens which arrive here. The long, strap-shaped leaves of date seedlings can be found in profusion on some waste-tips, and it is not unknown for the pips of citrus fruits such as lemons to germinate there, although such seedlings seldom survive our winter weather. Unexpected species may arrive with horticultural specimens, imported timber, or even clinging to the clothes of homeward-bound tourists.

Above: The beautiful blue-flowered apple of Peru (*Nicandra physaloides*) appears as both a garden escape, and as an impurity in Canary grass and millet seed, while the thistle-like safflower (*Carthamus tinctoris*), shown left, grows from seeds which arrive as parrot food.

Below: The seeds of Italian millet (*Setaria italica*) are found in cage bird-food and may germinate on waste tips when the cage waste is disposed of.

Where to look Rubbish tips may not seem the most obvious places to make fascinating botanical finds, but they can yield a rich harvest of unusual species including lentils and chick peas. Absence of competition from already established plants favours germination and growth, and a wide variety of seeds may arrive among the discarded cleanings from industrial processes, as well as in domestic refuse.

Aliens are also often found growing in docks, loading yards and railway sidings, although these areas generally have a more restricted range of species. The plants appear where goods containing the seeds have been unloaded and, as suitable ground in which to grow is in short supply in these places, the aliens tend to be represented here by weedy species which can grow in almost any corner.

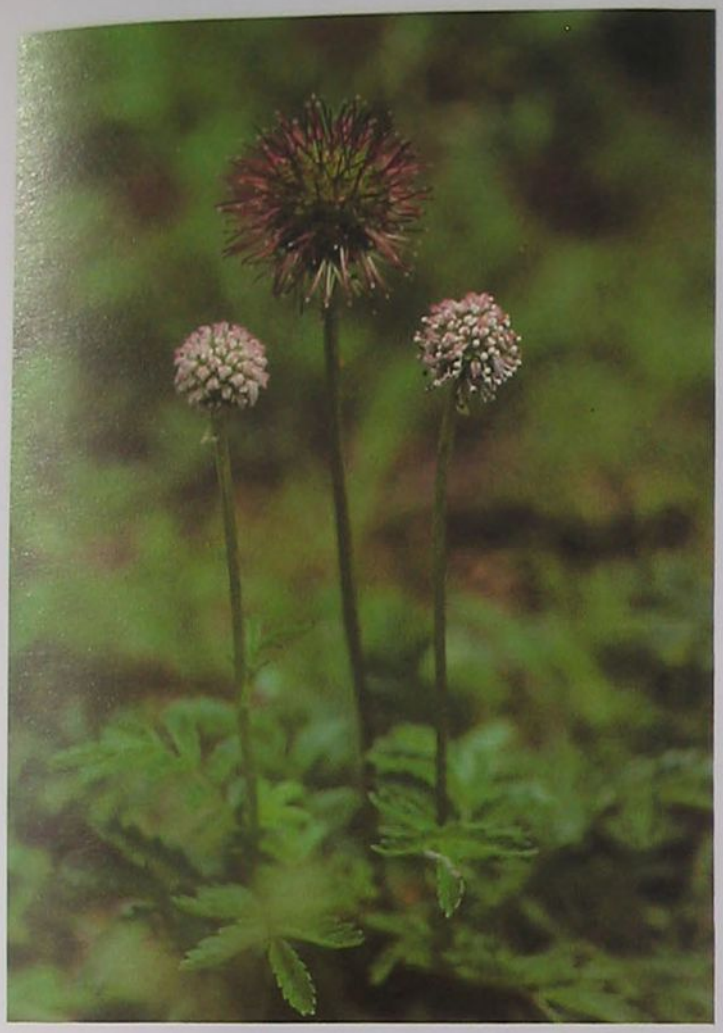
Grain and animal food Aliens arrive in this country from all over the world, and the type of alien and its means of entry into the country is almost invariably linked with a particular economic product. The commonest species are those which arrive in grain and seed imported for crops and animal feed, for malting and for flour milling.

Crop seed was formerly a rich source of aliens, the seeds of weeds growing among a crop being harvested along with those of the crop plants in their home country. The weeds then reappear in any field sown with the crop seed. Saint Barnaby's thistle, a European relative of our native knapweeds, appears among crops of lucerne while an American species of nightshade, *Solanum sarrachoides*, arrived here in carrot seed imported from the USA during the war. However, more efficient seed cleaning techniques, and improved quality controls, have considerably reduced the number of aliens imported in this way.

Controls are less strict on animal feeds and the cheaper forms of milling grain. Aliens from these sources can be found growing where the corn is stored or unloaded prior to processing. A member of the cabbage family from central Europe, for example, occurs along the banks of the Liverpool canal, having arrived here as impurities in Russian corn ground in the flour mills of Bootle.

Bird-seed aliens The British love for cage-birds has been responsible for the arrival of many alien species. Importation of bird-seed for both cage and wild birds is responsible for more than 200 different alien species recorded in Britain.

Bird-seed aliens appear regularly on rubbish tips, having been swept up when the



Above: Wool aliens appear in a variety of places. They grow in railway yards, on rubbish tips and waste ground near wool mills, as well as around the mill buildings. They are also found in fields well away from the great wool centres, and for a long time the reason for their growth on these sites was a mystery. The aliens were finally traced back to the shoddy, or wool waste, which is used as manure—especially on light soils in market garden areas. The shoddy, complete with full array of alien seeds, was taken from the factories and spread on the soil, where the seeds germinated. *Acaena anserifolia*, sometimes known as the pirri-pirri-bur (above left) is one of the few wool aliens which has become firmly established here, while *Xanthium spinosum* (above right), is found only in scattered localities. It has a variety of apt and descriptive common names, including spiny cocklebur, Bathurst bur and barbed-wire plant.

cages are cleaned and the waste disposed of along with other domestic rubbish. An increasing number of bird-seed aliens are appearing beneath bird-tables, or where bird-food has been scattered by thoughtful householders.

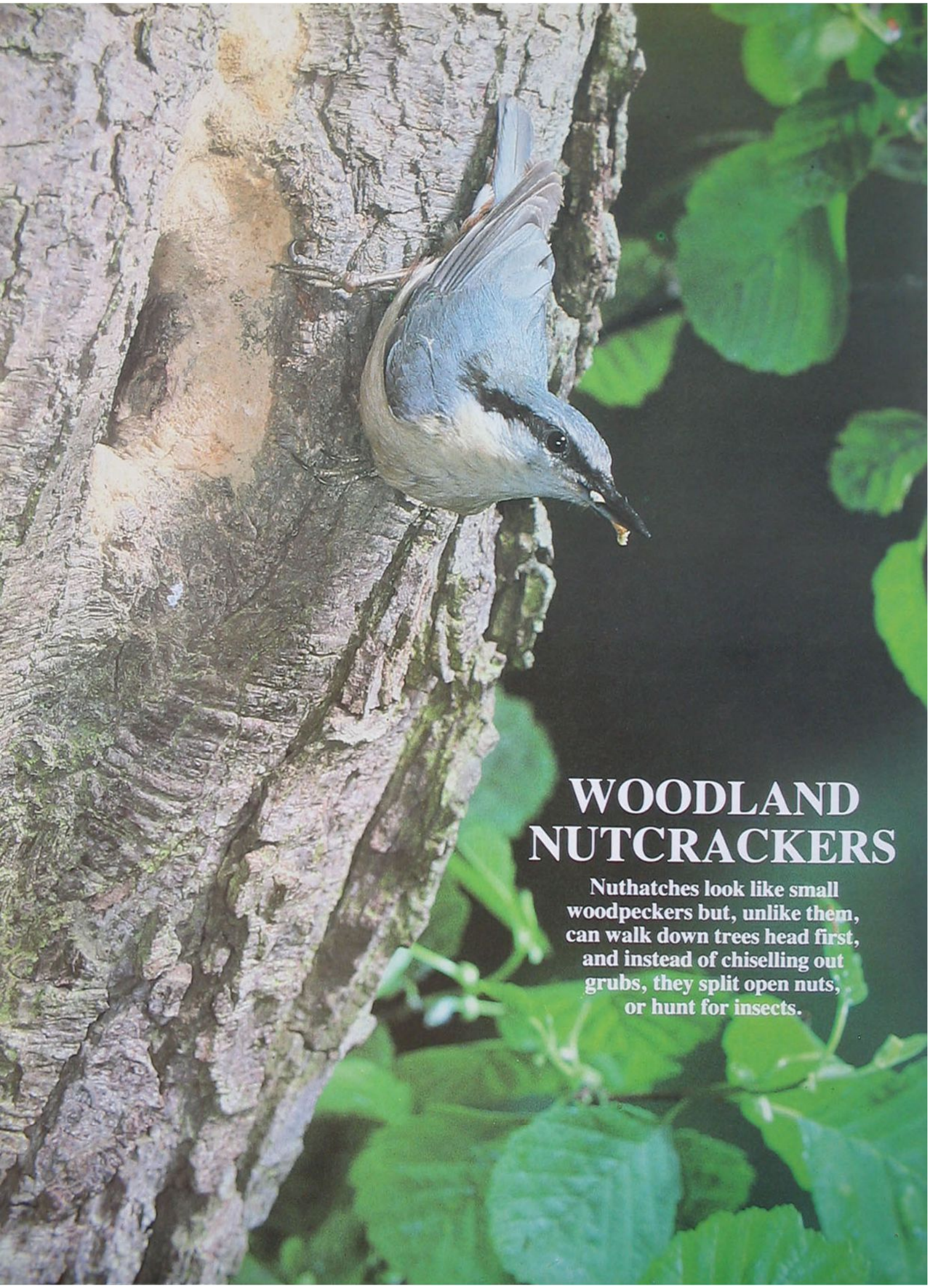
Most bird-seed mixtures are made up of a few types of staple seeds, usually those of grasses. Canary grass from Morocco, and broomcorn millet from America are common staples which regularly appear as aliens. Italian millet, which provides the millet sprays used for budgies, is also frequently found.

Some exotic escapes grow from seeds found as impurities in the staple foods or imported with a special purpose. The saf-flower, a native of southern Europe, arrives here as parrot food and hemp or cannabis arrives in seed mixtures, producing a tall, striking plant with lobed leaves. The seeds of sunflowers, found in pet food, may germinate if discarded, to produce the well-known large, yellow, disc-shaped flower.

Arriving with the wool Another major source of aliens is connected with the wool industry. As sheep graze, burs and hooked seeds very often become caught and immovably entangled in their wool. After shearing, the fleeces are sent to factories where the raw wool is cleaned before being made into cloth. Mechanical cleaning methods are sufficient to remove most seeds and other material, but burs are more tenacious. They are dealt with by the process of carbonising in which the wool is treated with chemicals such as sulphuric acid and passed between heavy rollers which crush the burs. The remains are then separated from the wool. A certain amount of wool clings to the seeds and burs after their removal, and this waste—called shoddy—is discarded. Surprisingly, such harsh treatment does not destroy the ability of all the seeds to germinate.

Wool is imported from Australia, South America and Europe, bringing with it plants from these Continents. The unicorn plant comes from South America and arrived in this country in wool from Uruguay. Its seeds have numerous small projections and two vicious-looking curved spines which become deeply embedded in the fleece. The spiny burs of the barbed-wire plant, or Bathurst bur, are common in wool from its native Australia, and fruits of medicks, storksbills and grasses also get caught up in fleeces.

Despite the many kinds of alien plants which appear here, few become established for more than a short period, mainly due to our uncertain and often unfavourable climate. One exception is *Acaena anserifolia*, originally a wool alien, but now a dominant member of the vegetation on Holy Island. A few of the aliens are naturalised in the Scilly Isles and the Channel Islands, where the southerly climate is more favourable, but generally aliens are unusual, transient visitors.



WOODLAND NUTCRACKERS

Nuthatches look like small woodpeckers but, unlike them, can walk down trees head first, and instead of chiselling out grubs, they split open nuts, or hunt for insects.

Although superficially similar to our woodpeckers in its choice of habitat and in its behaviour, the nuthatch is generally thought to be more closely related to the tits and treecreepers. True, it climbs with great ease even on the trunk of the smoothest-barked beech tree, but the nuthatch's toes are arranged three forward, one back, as in the other families of birds within the passerine order, not two forward, two back as in the woodpeckers. It is also true that the nuthatch has a large, dagger-shaped beak just like a woodpecker's, but this is the result of 'parallel evolution' (in other words it has evolved over the ages to do the same sort of work, but in a totally different bird), and the nuthatch lacks the extremely long tongue that the woodpeckers use to extract their insect food.

There are other, subtler differences. Woodpeckers always move head-up on a tree-trunk, leaning back on their stout tail feathers as if these were a shooting stick. But nuthatches can move with similar ease head-up, head-down, or horizontally across a trunk. Their tails are short, and the tail feathers are of normal shape, flexibility and toughness: only rarely do they come into contact with the bark at all, and nuthatches are able to rely on their strong claws alone to maintain their position on the trunk.

Nuthatches are attractive woodland birds, slightly more than sparrow-sized, neat but not gaudy. They are dove-grey above, white on the throat and the sides of the face, and a rich, cinnamon-tinged fawn on the belly. On each flank, and extending up under the wing, is a rich chestnut patch, considerably more extensive in area and darker in colour in the male than in the female, so with a little practice it is possible to separate the two sexes. The effective-looking beak leads to a striking long narrow black patch, running through the eye and backwards on to the nape.

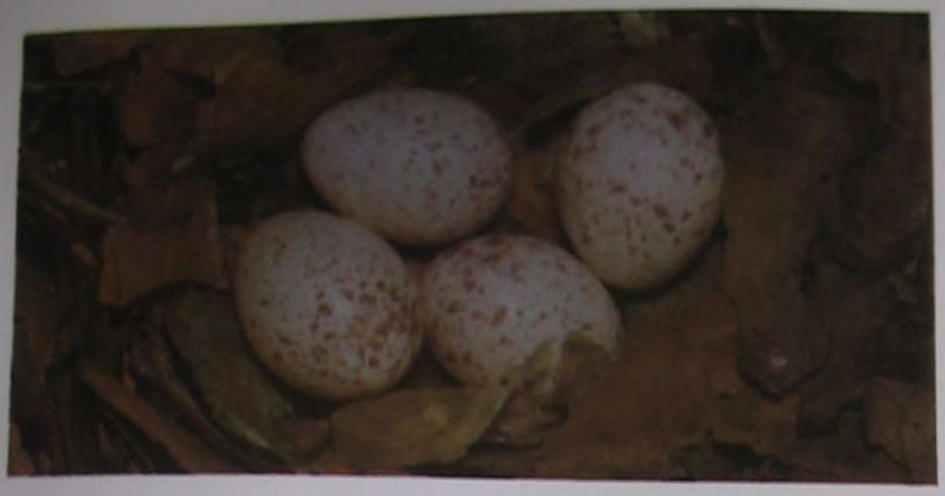
Wing display When a nuthatch flies directly overhead, its underwing pattern becomes visible: the underwing is silvery white and grey, with a black blob beneath the carpal joint (equivalent to the wrist). In much the same way as kingfishers, nuthatches flick their wings open and shut while perched during display. The other feature of display is the song: a loud, clear and ringing trill in rapid tempo. Most other nuthatch calls are loud and clear, too, particularly the often-used metallic 'chwit-chwit' and piping 'twee'. They are at their noisiest in late winter and early spring, but once breeding gets under way they are much quieter, so much so that you might suspect that they had left the area.

Nuthatch distribution This is rarely the case, for nuthatches are among the most sedentary of our birds, rarely moving more than a mile or two from the area of their birth. Their distribution is an interesting one: over an area roughly south of a line from the Wirral to the Wash they are widespread – except in a few lowland areas, principally in Cambridge-

Nuthatch (*Sitta europea*): resident tree-creeping bird found in woods and parks with mature trees; feeds on hard seeds and nuts, as well as insects and larvae; length 14cm (5½in).

Above: The larger and harder nuts, such as acorns, beechmast, hazel cobs and chestnuts, are often carried in the nuthatch's beak and wedged in a crevice in the bark of a tree, or perhaps in a wall. The nut is then hammered and split open with the beak (right).

Below: The nuthatch's toes are arranged three forward, one back, unlike those of a woodpecker, two of which face forward, and two back.



shire, which is probably because there are few suitable woodlands. North of this line, there is an outlying area, mostly in Yorkshire, where they occur, but very few other breeding records.

Their range seems to have contracted southwards, as the birds left their northern English haunts, during the 19th century, and at the same time it was noted that they had deserted the parks of central London and some other large urban areas. One suggestion is that this might have been due to increasing atmospheric pollution in industrial areas, reducing the insect food supply. This is borne out by the gap between the present-day Yorkshire outpost and the main area of distribution, this gap corresponding with the location of much of south Yorkshire's heavy industry. Other species sensitive to industrial pollution – such as the kingfisher – are also missing from this area.

Though well-distributed in Wales, the nuthatch is another of those birds (such as the tawny owl and the woodpeckers) whose complete absence from Ireland seems so puzzling. One possible explanation is that being sedentary birds, and having poor powers of long-distance flight, nuthatches were unable to reach Ireland during the recolonization period that followed the last Ice Age, before the rising seas formed what is now the Irish Sea and created an insuperable barrier.

Nuthatches are birds of mature, or even old, deciduous woodland; they sometimes occur in mixed deciduous and coniferous areas, but rarely in woodland that is predominantly coniferous. They particularly favour areas where beech, oak, sweet chestnut, hazel and hornbeam occur, for these provide winter food. Open parkland and, in many parts of England and Wales, large gardens with very old trees, also appear to be attractive to them.

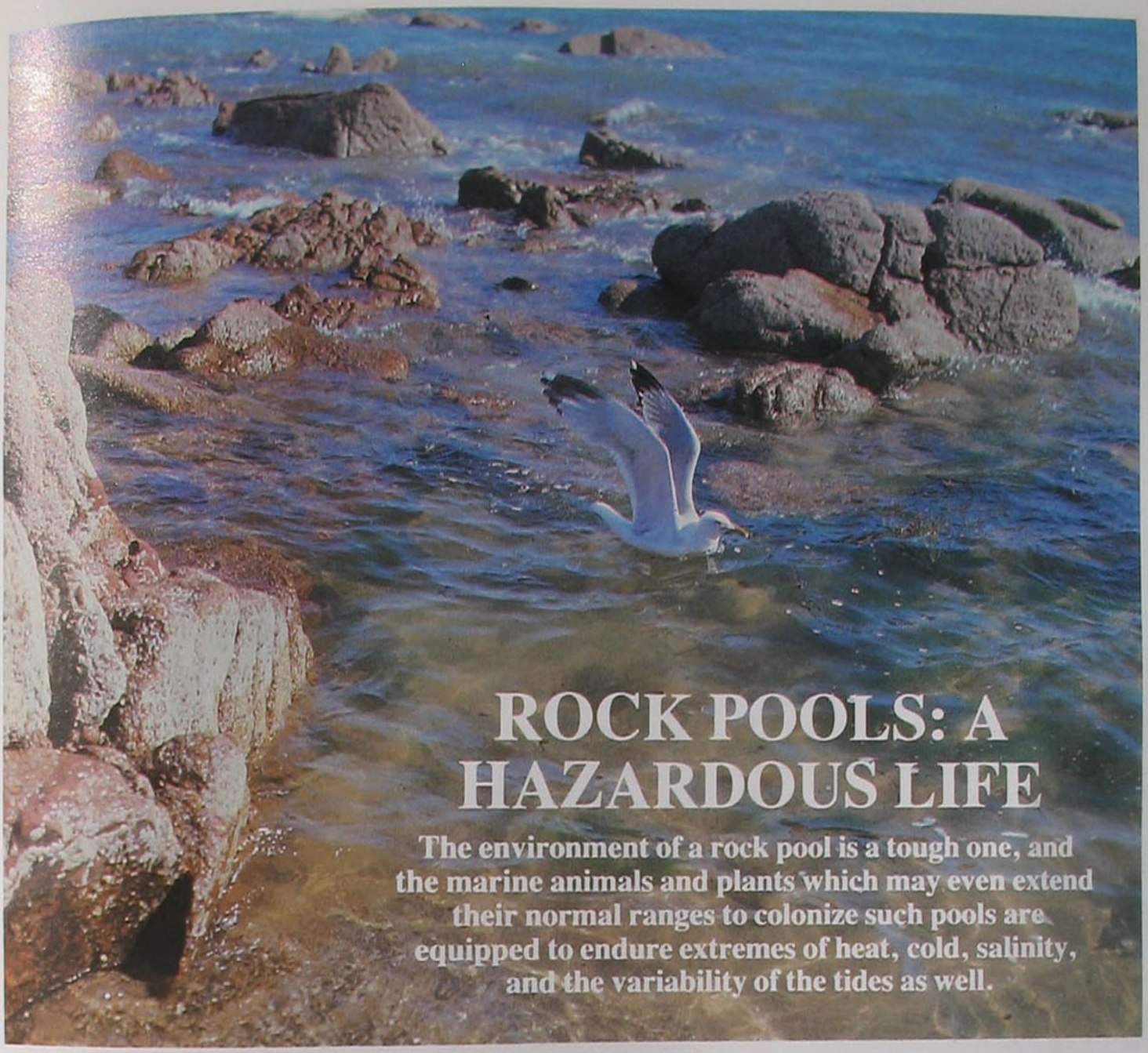
Although the species is widespread within its area of distribution, the nuthatch is not a numerous bird in Britain. There are many sites that seem highly suitable, but where there are no nuthatches at all. Recent estimates put the number of pairs between 10,000 and 20,000, which compares unfavourably with ten times that number of coal tits, but is roughly equal to the breeding population of the lesser spotted woodpecker and the long-eared owl.

Above: Nuthatch eggs, resting on a bed of yew bark flakes. The usual clutch is of six to nine white eggs, heavily spotted with dark reddish brown. Occasional clutches of as many as 13 eggs may well be the product of more than one female.

Below: Both parents share in feeding the young, which fledge after about three weeks or rather longer if the weather at the time is poor. Like the tits, nuthatches produce only one brood.

Patient plasterwork The nest is built in a natural cavity, usually in a decaying broad-leaved tree but sometimes in a little-used or deserted building. Most are within a few metres of the ground, but nests at least 20m (60ft) high are on record. Nuthatches take readily to nestboxes, but other, more extraordinary sites include disused woodpecker and sand martin holes, an old magpie nest and even a series (reported from Sussex) in haystacks. Neither the size of the cavity nor that of the entrance hole seem to influence their choice, and nuthatches have a habit – unique among British birds – of cementing up the entrance with mud until the hole is of the right size. When using nestboxes, they also plaster round the lid, from the inside.

Inside the cavity, the nest itself is also of a unique type. The eggs are laid on the floor of the cavity, on top of a layer of flakes of bark (especially of yew or larch if this is available), or of oak or other leaves. When the incubating bird (always the female) departs to feed or drink, she covers the eggs with similar debris, so on a superficial inspection the occupied nest looks like the long-deserted winter lodging of a field-mouse or dormouse.



ROCK POOLS: A HAZARDOUS LIFE

The environment of a rock pool is a tough one, and the marine animals and plants which may even extend their normal ranges to colonize such pools are equipped to endure extremes of heat, cold, salinity, and the variability of the tides as well.

Rocky shores are products of erosion, formed by the all-powerful sea with its armoury of crashing water, wave-flung stones and grinding sand. These weapons of erosion work more effectively on some kinds of rock than on others, making few inroads into a cliff of granite, for example, by comparison with easily weakened slates, shales and sandstones. On the grand scale of Britain's whole coastline these different rates of erosion make for bold headlands, offshore islands, sweeping bays and jumbled rocky foreshores.

On a local scale, the same forces are responsible for the formation of rock pools. Rock pools form as a result of geology and erosion, certain rocks being worn to a lower level than their neighbours, leaving depressions which can hold pools of water when the tide goes down. These rocky basins range from nothing more than a dent in the rock filled with tiny pockets of water to deep kelp-filled lagoons near low water mark.

If you visit the rocky shore at low water during spring tides, you'll see that more of the foreshore – pools and all – is laid open to the air than at any other time. And you'll find pools which, during neap tides (when the water falls less and rises less), are completely covered by the sea. But this is misleading, for once a pool, always a pool as far as the plants and animals are concerned, whether the tide is in or out – by living in a place which *sometimes* forms a pool, isolated from the rest of the sea, its inhabitants must be adapted for the rigours of pool life.

It is tempting to view a rock pool as a kind of wild aquarium, a refuge for creatures caught out by the receding tide. Although this may be partly true, pools in fact represent a specific habitat of the coast, where the plants and animals must tolerate a wide-ranging and sharply variable set of physical conditions which make them much more taxing places to live in than the adjoining shallow sea.

Environmental extremes A rock pool near the top of the beach may be cut off from the sea for several days at a time. Lower down it may be cut off for less than an hour on

Above: Pools on a rocky shore may well be completely covered at high tide, but as soon as the tide goes out the animals living in the pools, or stranded there, have to face extremes of temperature and salinity. There are a few simple rules to observe when watching the life in rock pools. A face mask makes it easier to see into the deep pools, and a clear plastic sandwich box makes a quick and easy 'viewer' in the shallows. It is important to put back any creatures you pick up for a closer look, and to replace seaweed pushed aside for a better view.

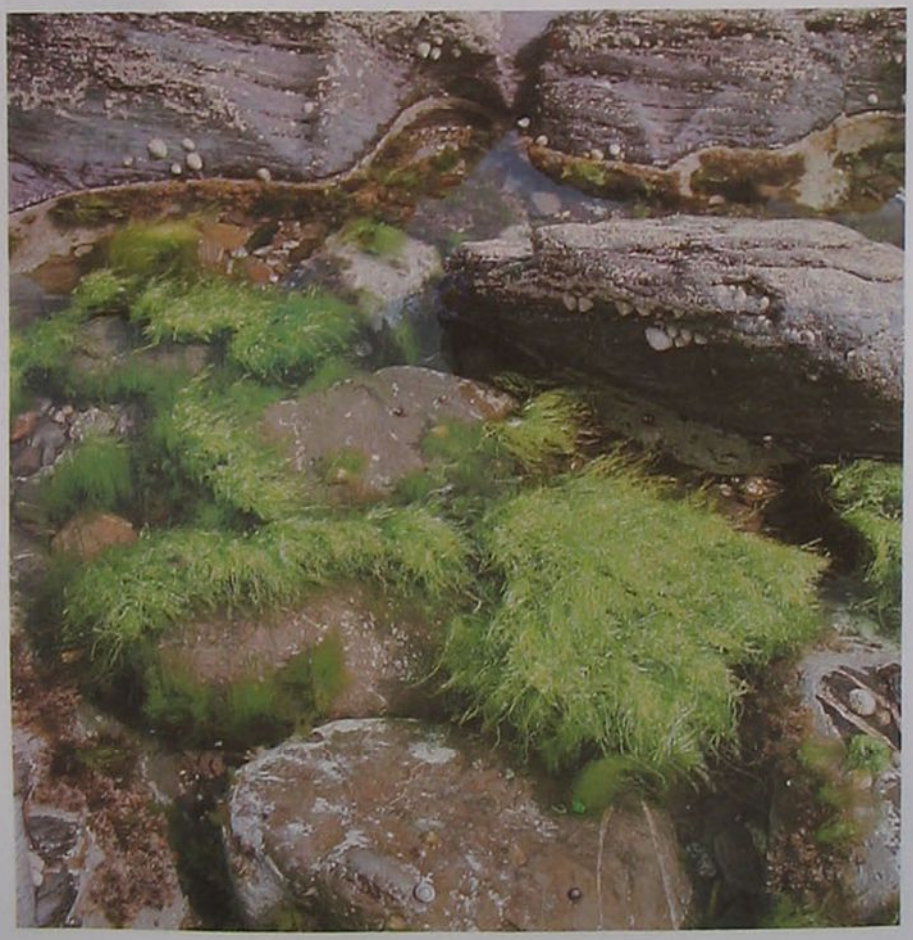
every tide. But however long the interval between tidal floodings, a pool must function on its own resources until the next infusion of life-giving sea.

During the day-time the plants–seaweeds–function by using light from the sun and carbon dioxide in the water for photosynthesis. The waste product of this process–oxygen–is in great demand for respiration by the animals which, in their turn, release waste carbon dioxide for the plants to use. Because much carbon dioxide is being used during the day, the amount is gradually reduced in relation to the amount of oxygen present. At night the regime changes as photosynthesis stops and respiration continues (though at a lower rate during the coolness of the night), making for a build-up of carbon dioxide and a loss of oxygen. So the plants and animals must be able to withstand a wide range of gaseous composition of their water. In addition, the accumulation of carbon dioxide at night makes the water increasingly acid, whereas the vigorous photosynthesis of the daylight hours leads to alkaline conditions.

Temperature and salinity are two more variables to be coped with. The temperature of the open sea is very slow-changing, but in a rock pool temperature changes follow the weather: a hot summer sun heats the water by several degrees, but at night the pool cools again rapidly. When the tide returns, the change is violent and sudden: in summer, for example, a relatively cool sea will swirl into a sun-heated pool, while in winter an isolated pool may be several degrees cooler than the sea which fills it on the flood tide. The salinity of a rock pool increases while the tide is low, the sun daily evaporating more of the water. This gradual change is reversed with a sudden rush when the tide finally returns. Salinity can be lowered by rain or fresh water draining from the land, but not uniformly, as the fresh water forms a layer over the heavier saline.

Above: One creature you may be lucky enough to find in rock pools on the lower and middle shores is the edible crab. It could be hiding in a crevice or under a rocky overhang, so all you may see is the tip of a claw poking out.

Below: Rock pools on the upper shore suffer from extremes of temperature and salinity. The green seaweed *Enteromorpha,* itself able to survive fairly well, plays host to such small creatures as sandhoppers.



All this may sound like a catalogue of troubles which would leave pools bereft of any life, but in fact plants and animals adapt to these conditions and flourish, the species found in any particular pool depending on the position of the pool on the shore. All rocky shores display zones, which develop in response to the amount of tidal covering and uncovering they get, where different species gain a foothold. Rock pools are found in all zones, and the position of a pool within the zones of shore life is the first guide to what is likely to live in it. Whether or not the typical creatures of a zone will be found in a pool then depends on their tolerance of the tough conditions.

Lower shore pools Pools on the lower shore suffer very small changes of environment because they are cut off from the sea for just a short time, and then only during spring tides. Especially if the pool is deep, it is little different from a slice of normal rocky sea bed. Large crabs–the edible and occasionally the spider crabs–or a lobster will hide in dark crevices or below rocky overhangs, and fishes like wrasse and pollack, which feed around rocky ledges, may be captive for a while. Even an octopus may lurk, waiting to catch a fish or a small crab. But the most interesting feature is that all the inhabitants–crabs, starfishes, brittlestars, sponges, hydroids, plumose anemones, scaleworms and so on–can exploit a greater area of the beach than usual by being in a pool, and still avoid the danger of desiccation.

Middle shore pools The best displays of rock pool life are found on the middle shore, where some pools persist throughout the tide cycle, being exposed to sun, wind, rain or

snow during neap as well as spring tides. Some of the most beautiful are the 'coralline pools', typified by growths of the red seaweed *Corallina officinalis*, which grows in short tufts around the shallow fringes of the pools. It cannot withstand drying out, and so rock pools give it an opportunity to extend further up the beach than it would on the exposed shore. This seaweed, and the often associated *Lithophyllum* species, which forms pinkish-purple encrustations, are very specific in their requirements and die if exposed for long to the air.

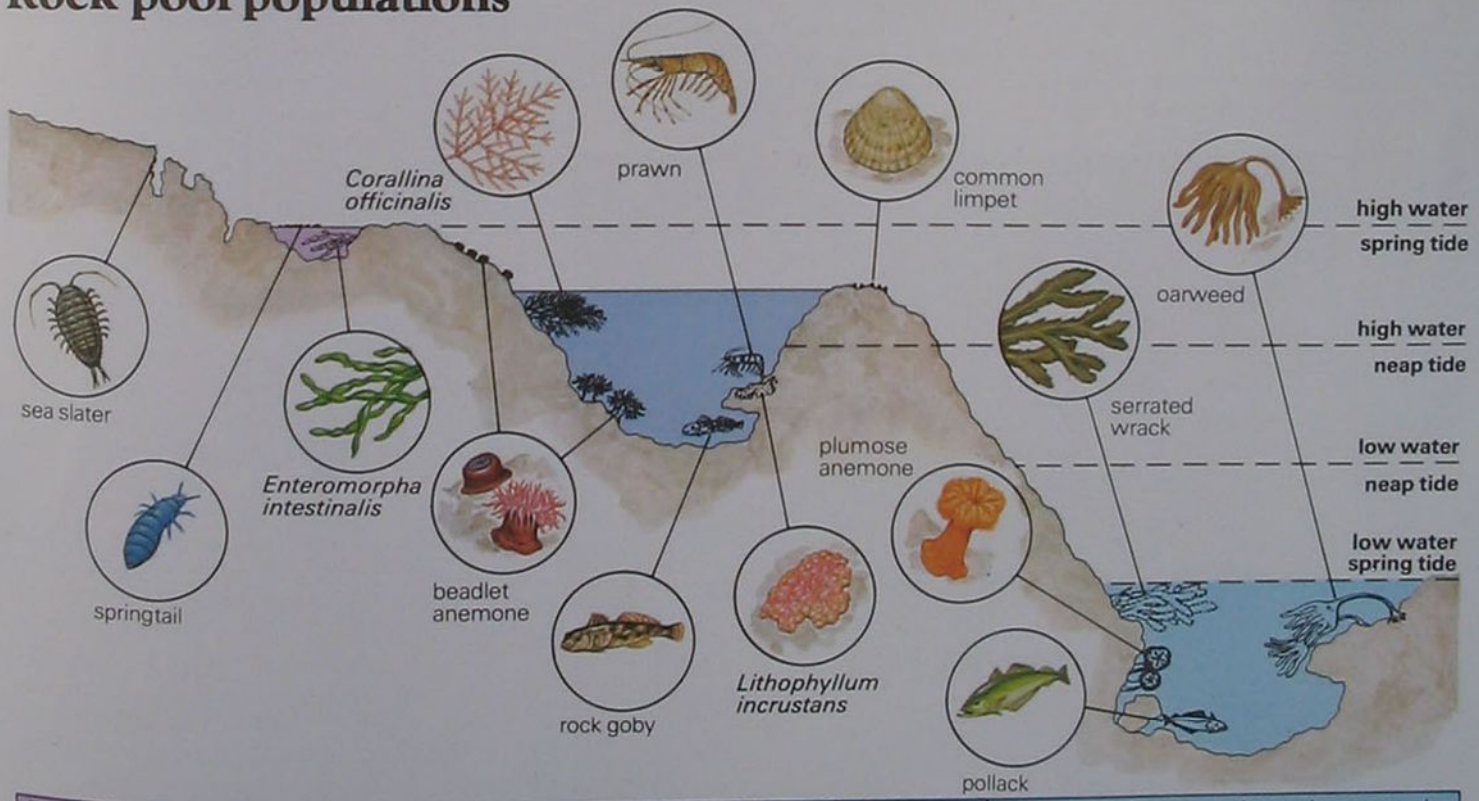
Many species of animals are similarly precise in their requirements, and if they flourish in a pool are often absent from the adjoining rocks. The barnacles, for example, and their common neighbours the limpets, live on the rocks and seal themselves from drying out, in preference to full-time submersion in a pool. Other species are more catholic, the beadlet anemone, for example, is common on the middle shore both in and out of pools. But like the seaweeds, the sea anemones are seen at their best in the water. The beadlet, one of the most common, looks like nothing more than a blob of dull red jelly when deserted by the tide, but in the pool, especially where weed casts some welcome shade, it can be seen in its full glory with long tentacles extended ready to enfold some small creature of the plankton. Much larger than the beadlet is the dahlia anemone, which may be found in a shady part of the pool.

To watch these creatures you must ap-

Above: A goby—one of many species found in British waters—trapped in a shallow pool on the upper shore. It is equipped with sucker attachments on its underside which enable it to grip the rock as the waves come pounding into the shallows, where it is usually found.

Right: A rock pool of the middle shore: dwelling here are a sea slug, mussels, winkles and several snakelocks sea anemones.

Rock pool populations



The sea may reach an **upper shore pool** at spring tides only—hence it suffers from temperature/salinity extremes.	Spring and neap tides both affect a **middle shore pool**—regularly covering it and exposing it to the elements.	A **lower shore pool** may be covered most of the time, only occasionally being open to the effects of the weather.

proach with stealth. A probing finger will quickly cause an anemone to withdraw; a shadow or a ripple will warn a darting prawn to seek cover or the hermit crab to retreat into his shell. The scavenging hermit, indeed, is a characteristic sight, scuttling about in rock pools. You may be lucky enough to catch it when it is changing over from its old shell to a larger one; it may start with a tiny top shell, graduating to a whelk shell home. With a careful approach you may also see prawns walking forwards in search of small fry, swimming or shooting backwards if you give them a surprise. Summer is the time to watch out for these prawns for, although they can put up with a wide range of temperatures, they move away from the pools to deeper, warmer water at the beginning of winter.

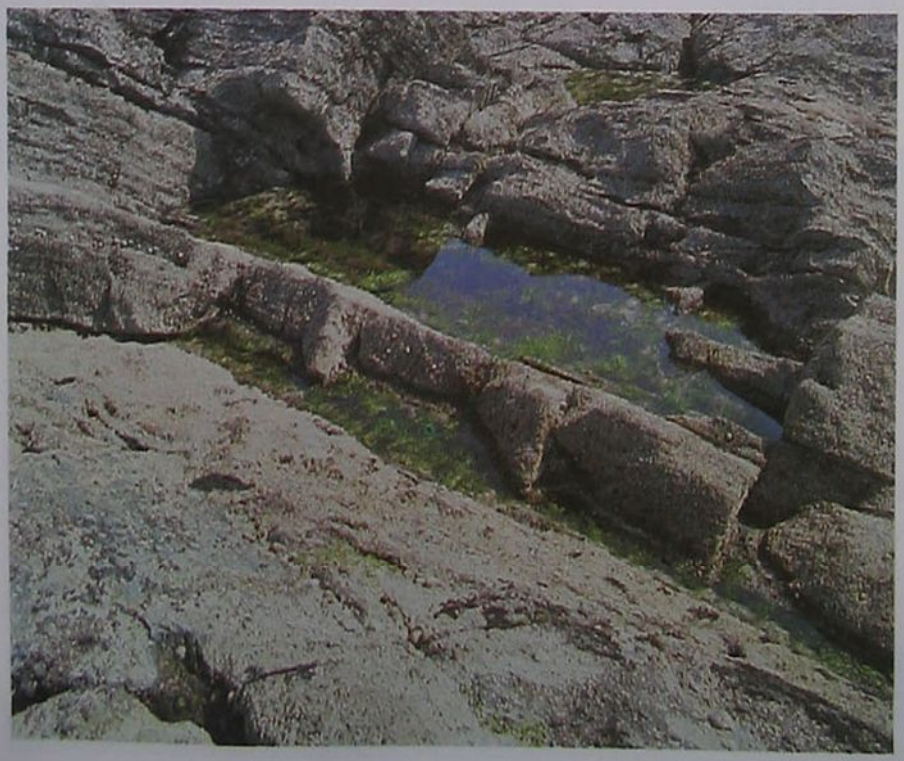
High level pools For marine organisms, conditions are at their most extreme in pools high up the shore where the sea reaches only at spring tides, or where salt water arrives merely as spray in the splash zone. Here the water, heated and cooled for long periods at the whim of the weather, is more brackish than salt and the species that live in it are reminiscent of those in estuaries.

Amid the bright green *Enteromorpha* seaweed are creatures which can cope with very low salinity: small crustaceans like sandhoppers which have a very wide salinity range; the ubiquitous shore crabs which are able to increase the saltiness of their own system when external salt conditions fall too low; and the tiny three-spined stickleback which never extends far down the shore. Swarming on the water may be hundreds of tiny springtails – bluish-black insects which move about on the surface film on small, sheltered pools. When the tide comes in they retreat to cracks in the rocks until calm returns with the next low tide.

Above: Rough winkles and barnacles in a small rock pool. These creatures are quite able to withstand drying out – they just seal themselves up until the tide returns. In fact, they may even prefer this mode of life to being submerged all the time.

Right: You can often find springtails – rather primitive insects – moving about on the surface of shallow rock pools high up the shore. Here a group of them are feeding on an upturned limpet.

Below: A rock pool at mid tide level with *Enteromorpha* seaweed. The harsh, bare rocks will provide no refuge for the animals of the pool, should the water dry up. It is a precarious habitat.



Rock pool fishes The several species of small fishes common in rock pools may be held captive for a while, but in the pools they are safe from drying out, and quite able to withstand the higher temperature. Their main adaptations, however, are to life in the turbulent shallows rather than to pools in particular.

Fishes which spend most of their time close inshore are in danger of being smashed against the rocks, and so an ability to grip the rocks in the face of the waves is very important. The lumpsucker, for example, has a powerful sucker on its underside, formed by the joining of the pelvic fins. In spring the adults come to the pools to breed, and the eggs, guarded by the males, spread a pink carpet over stones and weeds. The young fishes are common in mid and lower level pools in summer, moving to relatively warmer waters offshore for the winter. The gobies, of which there are many species found around Britain, also have sucker attachments.

When the tide is out there is no danger from crashing seas to a small fish in a rock pool, but every chance of being caught by a searching gull. So camouflage and a quick escape are helpful. The aptly named butterfish, which often hides under stones at lower water instead of in pools, is a very slippery customer, and the bullheads, or sea-scorpions, are well camouflaged with mottled bodies.

OCEAN GIANTS: BALEEN WHALES

The huge baleen whales of the northern hemisphere migrate from the equator during spring, arriving in northern waters in mid-summer when plankton and fish are most plentiful. They feed by filtering food-laden seawater through their baleen fringes.

Above: The humpback whale tends to swim near the surface of the water. It gets its name from the way it arches its body as it submerges its head after taking a breath of air. Its very long flippers – the longest of any whale – are also helpful in identification.

The great whales of our oceans are, with one exception – the sperm whale – members of the sub-order Mysticeti. These are the baleen whales, so named because they have huge jaws lined with horny plates called baleen, which sift out organisms from small planktonic crustaceans to fishes as large as herrings. The Mysticeti are divided into three families: the Balaenopteridae, the Balaenidae and the Eschrichtiidae.

Baleen sieves Baleen is an extraordinary substance, unlike anything else found in the animal kingdom, and bearing no relationship to teeth. It is a fibrous yet flexible material that grows as a series of thin plates, each the shape of an elongated triangle, hanging down from the margins of the upper jaw by its shortest side.

The outer edge of the baleen is smooth, but the inner edge is frayed into a fringe of coarse filaments which form a dense fibrous filter system. This is used for straining plankton from the sea water (see overleaf). This type of feeding, called 'gulping', is used by all the balaenopterid whales – blue, fin, sei, Bryde's and minke, and by the humpback. The baleen of the humpback is comparatively short, although there may be as many as 400 plates in each jaw, and its throat is covered with a system of grooves, rather like tramlines, which enable it to expand.

However, some baleen whales, notably the North Atlantic, Greenland right whales, and the gray whale, capture their prey by 'skimming', as does the sei whale on occasion. These swim slowly forward with mouth slightly open, allowing water to flow into the mouth cavity and out again through the baleen plates at the sides.

In the right whales the head is large, often up to a third of the total length of the body, so as to accommodate the highly developed baleen apparatus. The rostrum (the 'bonnet' on top of the head) is long, narrow, and arched upwards. The lower jaw-bones are not arched in the same way, so that the space between the upper and lower jaws is closed by the huge lower lips that rise from the jaw-bones and enclose the long narrow plates of

Black right whale
Balaena glacialis
18.5m (60ft), 40–50 tons

Humpback whale
Megaptera novaeangliae
14m (46ft), 31 tons

baleen that hang from the edges of the rostrum.

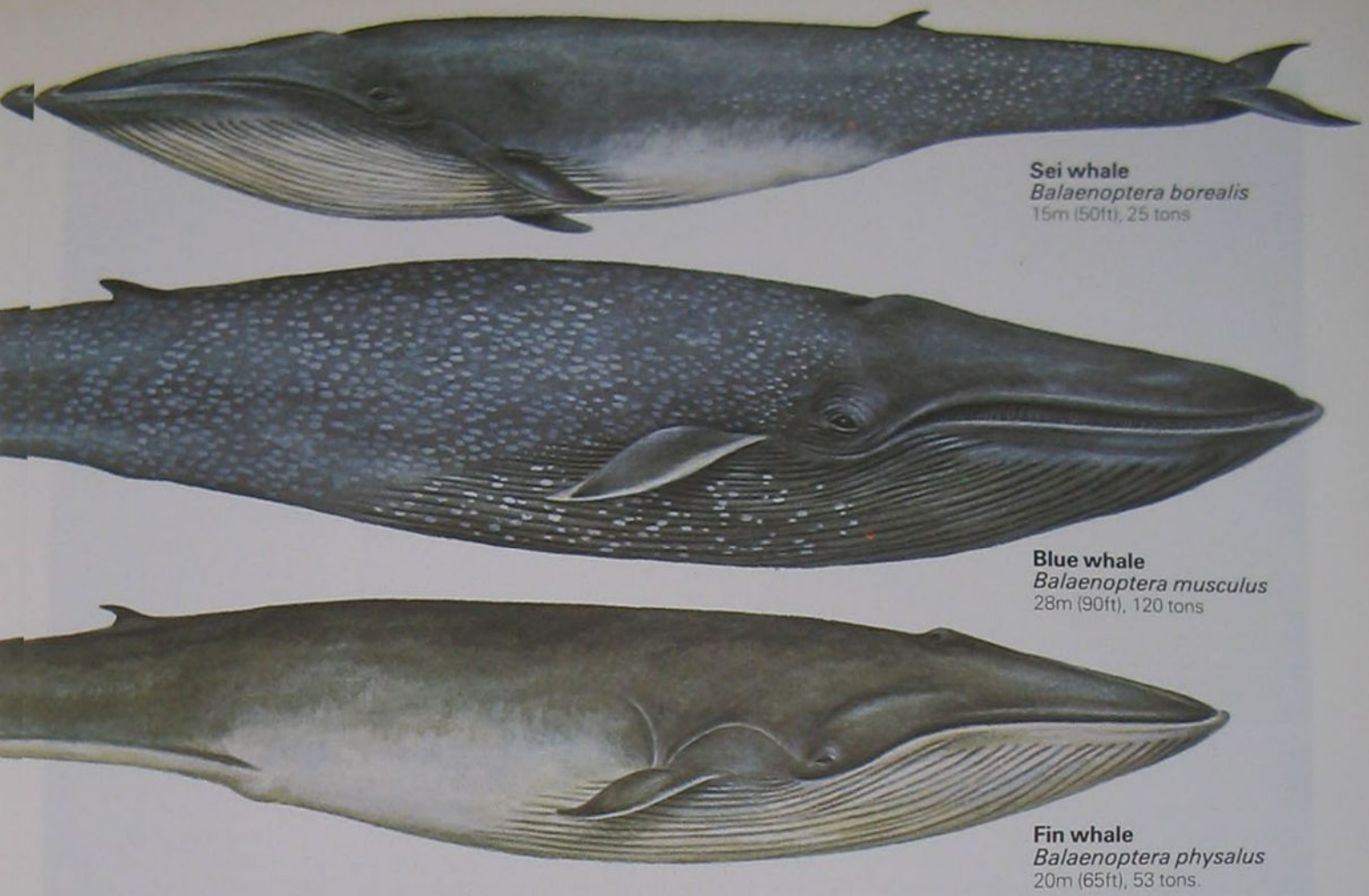
The gray whale has a shorter baleen and fewer throat grooves (usually 2 or 3) than the balaenopterids. These differences in the size and arrangement of the baleen plates reflect not only differences in the mode of feeding, but also the types of food taken. Those with the finest baleen plates, such as the right and minke whales, take the smallest plankton. Species with coarser baleen, such as the fin whale, eat such food as prawns and shrimps.

Food and feeding It is the differences in diet of the different species that prevent too much competition where these species occur together, although clearly the impact of one whale species on its main food has repercussions on its relatives. For example, around the beginning of this century the largest of all whales, the blue whale, was hunted to near extinction. The reduction in numbers of this species must have provided a great abundance of food, not only for the remaining blue whales but for other species as well, since blue, fin and sei whales all started to grow faster, reproduce at an earlier stage, and a higher proportion of females in the population became pregnant.

The principal food of all these species, at least in the Southern Ocean, is krill. It is shaped like a shrimp, though quite unrelated to one, and is very rich in protein. For this reason man has concentrated efforts where the species is abundant round Antarctica, to harvest it for food, and this may bring us once more into conflict with the great whales. The baleen whales are not the only species to feed on krill, for it forms the base of the food pyramid of many other predators, particularly certain species of seals, penguins, albatrosses and other petrels, many fish, and probably also squid.

It has been calculated that the large rorqual whales feed at a rate of about 4% of their body weight a day during the 120-day feeding period they spend in the Southern Ocean. Since a large whale, such as a fin or blue whale, can take a meal of 800-1000kg of krill, it is possible to calculate, given the

Below: The minke whale (*Balaenoptera acutorostrata*) is the smallest of the baleen whales. It weighs 10 tons and is up to 9m (30ft) long. It is sometimes seen from ships, jumping out of the water, and is relatively common around British coasts.



Sei whale
Balaenoptera borealis
15m (50ft), 25 tons

Blue whale
Balaenoptera musculus
28m (90ft), 120 tons

Fin whale
Balaenoptera physalus
20m (65ft), 53 tons.

known average densities of krill, the number of gulps it needs to make each day. For both species this is estimated to be between 70 and 80 gulps. Smaller species require proportionately more gulps. Clearly, very great quantities of krill are consumed, and the whales accordingly become very fat, increasing their body weight by 50-70% over this short period. This is necessary to last them the rest of the year, which they spend in the warmer, yet relatively unproductive, regions nearer the equator.

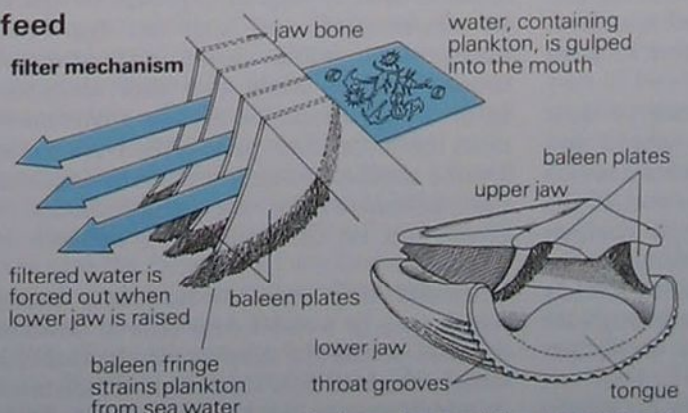
Not all the great whale populations migrate to the Southern Ocean. Some move north from the equator to Arctic and sub-Arctic waters where krill is not the principal food. Instead, there is a range of food organisms at lower concentrations than the krill of the Antarctic. The blue whale has a restricted diet in all oceans, taking only euphausiids such as krill. Minke whales have perhaps the most catholic diet, and together with humpbacks, also take large quantities of shoaling fish. The northern right whale, like the blue whale, has rather a restricted diet, principally calanoid copepods.

Migration The great migrations of the large whales take place annually. In the northern hemisphere, whales move north from the equator during spring, arriving in high latitudes by mid-summer when plankton and fish concentrations are at their greatest. As

Above: Some of the baleen whales which may spend part of the year around our coasts. Here they have no natural predators, and although many are protected species, their greatest enemy is man. They feed on a variety of food organisms, from small floating plankton to medium sized fishes.

Gulping: how whales feed

As the whale moves forward, swimming through the water with its mouth wide open, the floor of the jaw is lowered, the skin of the throat expanded as the grooves open out, and water loaded with plankton is forced into the mouth, which then closes. The muscles of the throat grooves contract, causing the floor of the mouth to tighten and driving the tongue forward, and the water is then forced out through the baleen fringes. The spacing of the parallel baleen plates allows a rapid flow of water without loss of rigidity to the filaments, so that the food contained in the water is left stranded on the mat from where it is swallowed, possibly aided by the tongue driving the food backwards to the gullet. This method of feeding is called 'gulping', and it is used by all the baleen whales.



baleen plates and jaw arrangement

Left: The tail of a right whale, showing its two horizontal tail flukes. If you manage to get a good view of the tail fin of a whale, the chances are that it will be a humpback, right or sperm (toothed) whale. They tend to raise their tail flukes right out of the water before diving.

the autumn gales start to disperse the plankton swarms, the whales return southward, arriving in equatorial waters by November or December, where they mate, or, twelve months later, give birth to their single calves. The same procedure is followed in the southern hemisphere but since the southern winter is at the opposite end of the year to the northern winter, these whales are never in equatorial waters at the same time as the northern group, and so there is little contact between populations.

The most extensive migrants are the blue, fin, minke, gray and humpback whales. They annually cover distances of 5-6000 nautical miles, and observations of migrating gray whales in the north-east Pacific suggest that they do not stop at all during migration, averaging about two knots when travelling north and four knots when swimming south. The rorquals tend to travel faster at speeds up to 16 knots, so it is feasible that they could travel between summer and winter grounds in a week or two. There is some suggestion that whales travel faster when moving to their wintering grounds, but this may not be related to the actual speeds at which they swim but to the number of stops they make on the way.

It is possible that on a journey to their summer feeding grounds the whales are exploiting spring blooms of plankton which they encounter en route. At the end of the summer, however, the food supply declines rapidly, the water temperature drops in the polar regions, and the whales, which already have a huge fat store to last them through the winter, need to migrate quickly to warmer waters.

Navigation and the senses How do whales in such a wide expanse of seemingly uniform ocean manage to find their way five thousand miles from one end of our globe to the equator? It is extraordinary to think that these animals can return year after year to the same tropical lagoon to calve, and then be found six months later in the same areas as the ice floes they frequented the previous year.

Yet individual recognition, either by natural markings, such as the arrangement of callosities on the 'bonnet' on a right whale, or by tags attached by research zoologists, has confirmed the regular use of particular regions by individual whales, just as migrating birds may breed or winter in the same area from year to year.

One method of navigation is almost certainly visual clues–prominent features of the sea-bed topography such as coastal escarpments and sea mounts. In the north-east Atlantic whales probably migrate along the edge of the Continental shelf, and this is supported by early 20th century whaling records which show concentrations of animals caught along the shelf edge.

It is likely, however, that a combination of senses is used by migrating groups of whales. In whales smell and taste are apparently unimportant, while vision, and obviously touch, are only useful over short distances. Information about the distant environment must therefore come principally from sound. Unlike toothed whales, there is no evidence that baleen whales use echo-location for navigation or communication between individuals.

Instead they emit low-frequency sounds which may be audible over tens to hundreds of miles across the deep ocean channels (the denser the medium, the longer the distances at which sounds can be propagated). This is how individuals keep in constant contact.

Whale songs

Whales can produce a great variety of moans, screams, grunts and whistles. In baleen species these are generally of low frequency, transmittable over great distances. Detailed studies have been carried out on right and humpback whales and these have shown the existence of dialects with song phrases which may differ both geographically and from year to year.

The song of humpback whales is made up of a constant number of themes repeated in the same order and lasting a considerable time. The themes are composed of phrases whose number may vary between successive songs of a particular whale. No theme is left out completely, although a whale may repeat a phrase many times. Phrases may change gradually so that one at the end of a theme may be quite different from what it was at the beginning. Such songs are apparently only uttered in warm waters by migrating animals, and each year the population has a characteristic pattern of themes.

Tape recordings of right and gray whale calls have been played to a group of right whales: right whales reacted to their own calls by approaching the tape-recording, but avoided those of the gray whale, a possible competitor.

FLIGHT: INSECTS ON THE WING

Most insects are very efficient flyers, whether they have one or two pairs of wings. Although their flight is apparently effortless, it actually involves a complex sequence of muscle actions and wing movements to keep them airborne.

Above: This triple-exposure photograph of a yellow underwing moth illustrates how an insect's wings beat up and down at the same time as they twist at the base, so that the hind edge falls below the leading edge on the up stroke. It then rises above the leading edge on the down stroke and the resultant air stream propels the insect forward while supporting it against the pull of gravity. Here, tiny scales have been dislodged from the moth's wings during flight.

Insects are the only invertebrate animals that can fly, an ability they developed an immensely long time ago, long before any of the vertebrate flyers–the birds, bats and extinct pterodactyls. The earliest fossils of flying insects date from about 300 million years ago, the time when our coal was being formed in the great swampy forests of the Carboniferous Period. Some of the earliest flying insects were also the largest that are known to have existed, such as large dragonflies with wings spanning over 60cm (2ft).

Not all insects can fly, however. There are many flightless species, both primitive forms whose ancestors have never possessed wings, and others that have lost their wings during the course of evolution. Typically, however, adult insects have two pairs of wings that are believed to have developed from lateral expansions on the two hind segments of the thorax. These lateral expansions are called paranota and can be seen in some fossils and also in some primitive and wingless insects found today, such as the silverfish. The wings of insects have therefore not evolved from structures that were formerly limbs, as have those of all the vertebrate flying animals.

Wing structure An insect's wing is formed from two very thin and often transparent layers of sclerotin, a strong but flexible substance which also makes up the harder parts of its outer body covering. The two layers adhere closely and appear as a single sheet or membrane, strengthened by a framework of hollow rods of sclerotin which are usually called the veins. Although they do play the part of blood vessels during the development of the wing, when it is fully formed their function is to support the flexible membrane.

The variation in number and arrangement of the veins can be used to identify species, as well as to distinguish primitive from advanced insects.

How insects control their wings In simple terms, an insect's wings work by beating up and down and at the same time twisting at the base. This has the effect of fanning a stream of air backwards and downwards, propelling the insect forwards and supporting

it against the pull of gravity. The wings are both powered and controlled by sets of muscles located in the thorax. Depending on the insect, flight involves either direct or indirect flight muscles.

Direct flight muscles act in a fairly simple way and are characteristic of large and rather primitive insects like dragonflies and grasshoppers. The wing pivots very near its base in the wall of the thorax and the muscles are attached to the wing base at points close to the pivot and on each side of it. Contraction of the inner muscles pulls the base down and swings the wing up, followed by contraction of the outer muscles which pulls the wing down.

The wings are powered in quite a different way in flies, bees, moths and other insects which also have well-controlled flight. The mechanism can be quite complicated, but in its simplest form it is made up of two pairs of muscles, a vertical pair and a longitudinal pair. These are called indirect flight muscles because they are not attached to the wings at all, but to the walls of the thorax. When the vertical muscles contract, the top of the thorax is pulled down, together with the base of the wing, so that the wing itself is swung upwards. It swings down again when the vertical muscles relax and the longitudinal ones contract, causing the top of the thorax to arch and push up, pulling the wing down.

Wing efficiency Various other accessory muscles brace the thorax against the action of the flight muscles, so improving the wings' efficiency and controlling various flight mechanisms. One of these is the 'click mechanism', found in flies and some other insects. In this mechanism the wings are held in their up and down positions by minute catches which are not released until the action of the indirect flight muscles has built up a degree of tension in the elastic walls of the thorax. This causes the wings to move up and down with a snapping movement, which gives increased speed and efficiency to the wing beats.

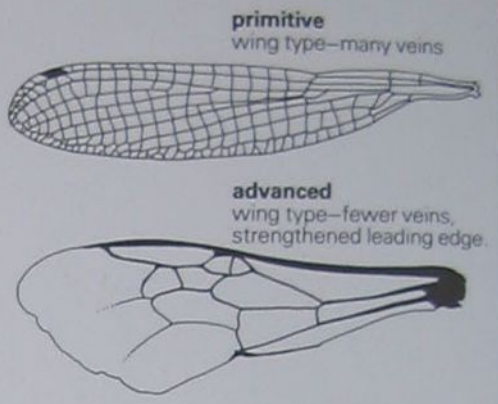
Small insects which possess the click mechanism have a very high wing-beat frequency. Bees and flies achieve about 200 wing-strokes per second, mosquitoes as many as 600, while one tiny species of biting midge reaches as many as 1000 beats per second. Calculations based on weight and wing size indicate that a bumble bee is theoretically incapable of flight. The fact that it can fly very well is due to the perfection of the mechanism that 'drives' its wings.

Large insects like locusts and dragonflies, lacking the click mechanism, beat their wings at fairly low frequencies of around 20 up-and-down strokes per second, although they are, nonetheless, efficient flyers.

Flight speed The actual speed of flight of insects is difficult to measure because they seldom fly far in a straight line. In fact, they do not fly very fast: bees and butterflies

All in the veins

Wing venation can be an aid to classification as well as identification of insects. Such primitive insects as dragonflies and mayflies have a close network of veins, while more advanced insects such as flies and bees have fewer veins. These tend to be thicker, especially at the leading edge of the wing which bears the greatest stress in flight.



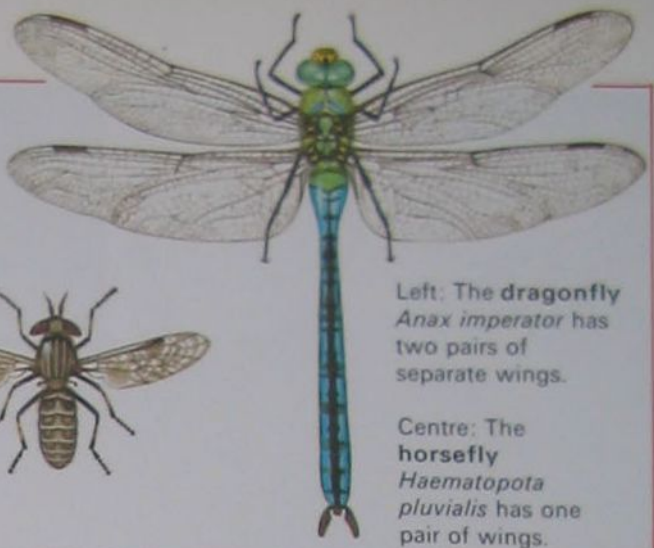
Right: Most beetles, like this cardinal beetle, can fly. Their forewings are hardened into protective and often colourful wing cases which are raised to expose the hind wings used when the insect is in flight.

Below: Some moths have a wing-coupling mechanism which ensures the wings work powerfully in unison. This male buff ermine moth has a bristle near the base of the hind wing which catches in a 'hook' on the underside of the forewing.

Wings in pairs

Most insects with rapid and well controlled flight have either only one pair of wings, as in flies, or two pairs coupled together so they work in unison. Bees and wasps for example, have a row of minute hooks along the edge of the hind wing which engage in a fold on the rear edge of the forewing. The fore and hind wings of dragonflies can operate independently.

Above: The **buff-tailed bumble bee** (*Bombus terrestris*) has two pairs of wings, coupled.

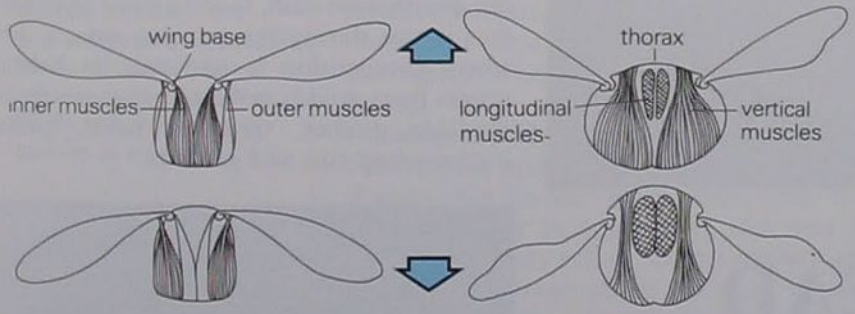


Left: The **dragonfly** *Anax imperator* has two pairs of separate wings.

Centre: The **horsefly** *Haematopota pluvialis* has one pair of wings.

Right: Insect wings are formed from two very fine layers of sclerotin, often transparent, as is the case in this dragonfly. Although dragonflies beat their wings relatively slowly—around 20 beats per second—this is enough to make them appear blurred while in flight. They are also able to operate their wings independently, which probably helps them to fly and manoeuvre at high speeds.

Wing muscles in action



Direct flight When the insect's inner muscles contract, the wing base is pulled down, causing the wing to swing up. When the outer muscles contract, the wing is pulled down.

Indirect flight Vertical muscle contraction pulls the thorax and wing base down, causing the wing to rise. Contraction of the longitudinal muscles arches the thorax, and the wing drops.

Right: Insects with two wings, such as the cranefly, are assisted in flight by a pair of halteres which look like tiny, knobbed rods behind the wings and are, in fact, highly modified hind wings. These vibrate at the same speed as the wings during flight and act as balancing organs, helping the insect to control its position.

average 10 to 15km/h (6 to 9mph), while a large dragonfly probably reaches 58km/h (36mph) in short bursts. Horseflies sometimes pursue vehicles, presumably mistaking them for horses or cattle, and keep pace with them at speeds of up to 40 to 50km/h (25 to 30mph). The large hawk-moths seem to be the insects best equipped for swift flight. Their fore and hind wings are linked together and driven by very powerful indirect flight muscles. Unfortunately, as they fly at night, observation of their movements is extremely difficult.

Flight fuel Insect flight is efficient, but it consumes a great deal of energy. Some insects store energy in the form of fat, others as carbohydrates in the form of sugar. Locusts, which make long migratory flights, consume fat and lose about one per cent of their body weight during an hour's continuous flying. In contrast, non-migratory blowflies, which get their energy from sugar, would lose as much as 35% body weight in the same amount of flying time. Thus, in general, insects such as butterflies and moths, which are more likely to undertake migratory flights, store their energy in the form of fat.

Long distance travellers Flying insects may travel great distances in one of two ways, or even using both methods at the same time.

Huge numbers of small insects such as aphids may be carried up by ascending air currents called thermals until they reach heights where strong winds may carry them for many hundreds of miles. All the insects need to do is keep airborne which, in such tiny insects, consumes a minimal amount of energy. In a direct comparison with the drifting plankton of the oceans, these weak-flying wind-borne insects are known as the aerial plankton.

Some large insects make deliberate migratory flights, nearly always in a particular direction and at a particular time of year. They include butterflies, moths, and dragonflies, all of which are powerful flyers. Red admiral and painted lady butterflies fly northwards from the Mediterranean region every spring, spreading across the British Isles, their powerful flying ability enabling them to cover the long distances involved.

WIDESPREAD RESILIENT RUSHES

Although wet places are not inhabited exclusively by rushes, there is scarcely a pond or stream side, wet meadow, marsh, fen, bog, or muddy seashore where one or more of Britain's thirty species of rushes cannot be found.

Above: Soft rush (*Juncus effusus*) in flower. It favours marshy habitats where it may grow to heights of 1.5m (5ft), while bulbous rush (*Juncus bulbosus*), opposite, rarely reaches a height of more than 20cm (8in).

Grasses, sedges and rushes tend to share the same kinds of habitats and often look much alike, but only the rushes have a recognisable flower. This is wind-pollinated and looks very much like a tiny version of the flower of members of the lily family – such as ramsons – although the families are only distantly related.

There are two groups of rushes in the British Isles. The first, the true rushes, have hairless leaves and many seeds in a fruit that is divided internally into three compartments. The second, the woodrushes, have hairy leaves and only three quite large seeds in a fruit that lacks internal divisions.

The true rushes are found in all shapes and sizes from small, inconspicuous annuals growing as garden weeds, to huge, tussocky perennials with spiny leaves growing on the seashore. Some species even grow in the exposed environment of the serpentine rocks of the Lizard, or on the rocky mountain tops in Scotland.

Looking at the leaf The problem with identifying rushes is that, unlike most groups, the flowers are less useful than the growth habit and leaf structure. While the flowers of most rushes are very much alike, the leaves exhibit a wide range of forms.

The simplest leaf is more or less flat, with several parallel veins running along its full length. In some species, however, the upper surface is much narrower than the lower so that the leaf is almost circular in section, but with a shallow groove along the top. In other species, the upper surface has vanished altogether and the leaf is truly circular in section with a cavity in the centre. The central cavity in one such group of species is full of pith, while in a second it is divided by transverse partitions (and sometimes also by longitudinal ones).

Widespread species Toad rush is probably our commonest rush, found almost anywhere that is wet during the growing season, and where competition is minimal. Its habitat ranges from muddy pond and stream sides to roadside ditches, trampled fields, paths, tracks, wheel ruts and gardens.

Above: Common rush (*Juncus conglomeratus*) is found throughout the British Isles, particularly on acid soils. It is very similar in appearance to the soft rush, but with small, compact inflorescences. The best way to distinguish between the two species when not in flower is to feel the stems. The stem of common rush is ridged, while that of soft rush feels quite smooth.

It is a small species with a very loose and open inflorescence and widely spaced flowers. The leaves are simple, but in some individuals they may be almost circular with a groove along the top.

Heath rush is fairly widespread in the British Isles on moors, bogs and damp heaths. It has the same kind of leaf as the toad rush – almost circular in section, but deeply channelled along the upper surface. The leaves are, however, much stiffer and thicker than those of the toad rush and grow in a manner unusual among rushes, being confined to a basal tuft lying almost flat on the ground. A characteristic of heath rush is that in the autumn the entire tuft of leaves is detached easily from the roots, and these brown, dry tufts are often seen scattered among the heather and tussock grasses.

Rushes of acid soils The small, rather grass-like bulbous rush is common throughout the country, but favours more acidic soils. It is rather variable in appearance and may be erect and densely tufted, or procumbent and rooting at intervals along the stem, or even floating in water and profusely branched.

Bulbous rush derives its name from its habit of producing small bulbous-based shoots instead of flowers, which means it is not always immediately recognisable as a rush. It can, however, be distinguished from grasses and sedges by its leaves. These are the most advanced type of leaf, being cylindrical, hollow and with transverse internal divisions known as septa.

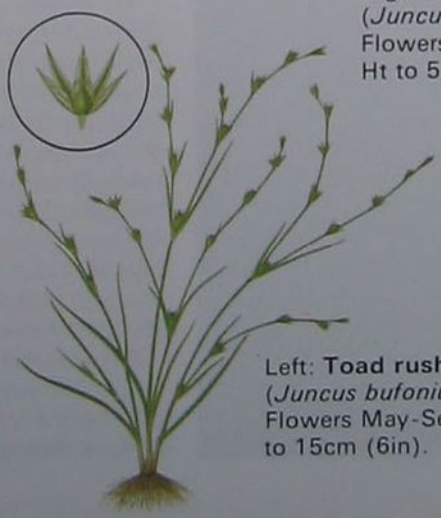
Jointed rush is another rather variable species, common on acid soils and particularly abundant in meadows or moors subject to grazing. Like bulbous rush, it has hollow leaves with numerous internal septa, but instead of being circular in section, the leaves are quite distinctly flattened. The inflorescence is loosely formed, bearing tight clusters of four to eight flowers.

Meadow and marsh rushes Three species – common, soft and hard rush – are most usually associated with damp meadows and marshes. They are all tall, reaching up to 1.5m (5ft) in height, and form dense tufts of straight, apparently leafless stems. The inflorescences, instead of being at the top of the stem, seem to project from one side of it about four-fifths of the way up. This unusual appearance is due entirely to the strange nature of the leaves. The base of the stem is clothed in brown scales which are the sheathing bases of leaves which have no blades. The only true leaf present is one that begins below the inflorescence and is almost indentical to the stem in appearance. This makes it appear as if the stem continues beyond the inflorescence, whereas in fact the inflorescence is at the top of the stem, not some way up it at the side.

A rush or not?

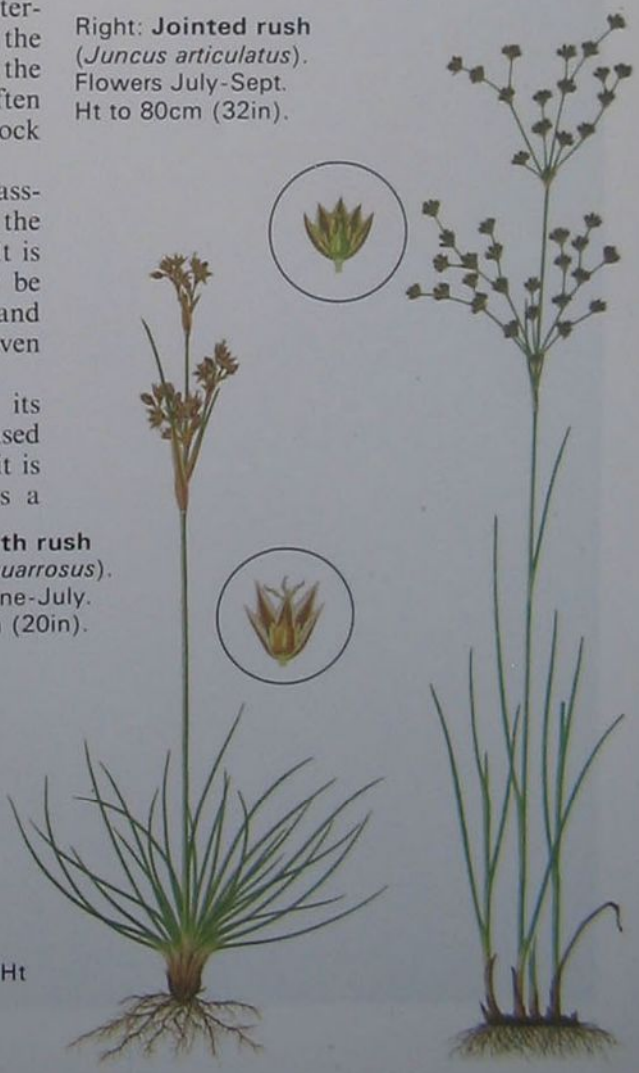
Despite its name, the flowering rush, noticeable for its attractive pink blooms, is not a rush at all. In fact, it is the only species in its genus.

Flowering rush (*Butomus umbellatus*). Flowers July-Sept by water. Ht to 1.5m (5ft).



Left: **Toad rush** (*Juncus bufonius*). Flowers May-Sept. Ht to 15cm (6in).

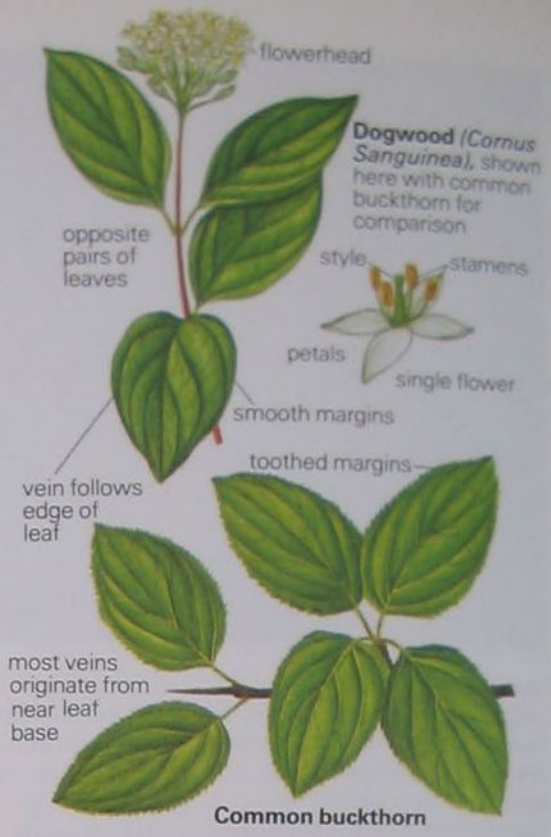
Right: **Heath rush** (*Juncus squarrosus*). Flowers June-July. Ht to 50cm (20in).



Right: **Jointed rush** (*Juncus articulatus*). Flowers July-Sept. Ht to 80cm (32in).

RED-STEMMED DOGWOOD

Inconspicuous for much of the summer, dogwood bursts into colour in the autumn as its leaves turn reddish-purple and then fall to reveal the red stems that make this plant one of our most attractive native shrubs in the winter.



Common buckthorn

Below: Dogwood is a shrub both of open sites and woodland. In the open, it bears clusters of tiny creamy-white flowers around mid-summer. However, in the shade it flowers poorly if at all, though in both sites it spreads by suckers.

Dogwood is a deciduous shrub found primarily in the southern half of Britain, particularly in south-east England on the North and South Downs. On these downs it is often seen growing with its associated shrubs, the wayfaring tree and the wild privet, and when you find these three shrubs together you can be sure that you are on highly chalky ground.

Away from the chalk downs, dogwood flourishes in limestone areas such as those on the Mendips, in the Avon gorge at Bristol, in the lower Wye valley and south and north-east Wales. It is also widespread in the Midlands and East Anglia wherever there are lime-rich soils, and can be found in a few limestone areas in northern England, though it thins out rapidly north of Yorkshire. It is absent from Scotland and occurs only very locally in Ireland.

Dogwood is best known as a common, sometimes dominant, constituent of downland scrub, but it also grows in woodlands, especially where oak or ash are present, and in hedgerows.

Winter brilliance Dogwood is a shrub with grey main stems and bright red twigs. In the winter, when it is leafless, these twigs are especially eye-catching and sometimes make the whole bush glow a deep rich red. However, to achieve such brilliant colours dogwood needs to grow in the open; in shady situations its twigs are often just a dull purple-brown.

In spring, the leaves appear in opposite pairs on the twigs. They are most notable for their pattern of veining: instead of reaching straight out to the leaf margin, as happens with the leaves of most British trees and shrubs, the veins of dogwood leaves curve inwards to become roughly parallel with the margins. The leaves of the common or purging buckthorn have a similar pattern of veining, but they can be distinguished by their toothed margins, the margins of a dogwood leaf being smooth.

Flowers and fruits In June, the ends of many dogwood shoots become covered with dense flat-topped clusters of small creamy-white flowers. These flowers are particularly beau-

tiful when seen under a hand lens: each consists of four (occasionally five) petals with a club-shaped style in the centre surrounded by four (or five) conspicuous stamens occupying the spaces between the petals. The flowers in the centre of the cluster usually open first.

Most people find the smell of dogwood flowers disagreeable but it attracts large numbers of pollinating insects. Besides these useful visitors there are also harmful ones: the larvae of the holly blue butterfly occasionally eat the flowers as an alternative to holly petals, and the leaves are sometimes attacked by green hairstreak caterpillars. But neither of these species is common enough to do serious damage.

The flowering period lasts into July and is followed by tiny round green berries. By September they have swollen to the size of small garden peas and are a glossy purple-black. Each berry is topped by the withered remains of the calyx and contains a single stone. To us the berries taste extremely bitter, but birds eat them readily. As the berries ripen the leaves turn a spectacular red-purple just before they fall in late autumn.

Why 'dogwood'? The name dogwood has been suggested to be a distortion of 'dagwood', a reference to the fact that the wood was once used to make meat skewers. The old name for a meat skewer is 'dag', hence the modern word 'dagger'. But the real origin of the name comes from one of the old meanings of the word 'dog'–worthless. For example, people spoke of dog daisies because they were held to be inferior to garden daisies. So 'dogwood' expressed the contempt that people held for the berries because they were so unpalatable. Thus the 17th century botanist, John Parkinson, wrote, 'We for the most part call it the dogge berry tree because the berries are not fit to be eaten or to be given to a dogge.'

The botanical name for dogwood is *Cornus sanguinea*. The name *Cornus* probably refers to the hardness of the wood, 'cornus' being Latin for 'horn'. The name *sanguinea* was given to the plant by the great 18th century botanist Linnaeus. It comes from the Latin for blood-red and possibly refers to the colour of the twigs in winter, but more likely to the lavish redness of the autumn leaves.

Long-time native Dogwood has been growing in the wild in Britain for many thousands of years. Among the remains of other plants, it has been found in the Cromer forest-bed of East Anglia, a buried fossilised forest that pre-dates the last Ice Age which started about 70,000 years ago. Presumably, dogwood retreated south during the Ice Age and returned to Britain afterwards as the temperate forest vegetation spread northwards.

As with so many of our native plants, dogwood once had a great many uses, which are now largely unfashionable. The wood is particularly hard, which made it ideal for tools needing a sharp, durable point, such as meat skewers and toothpicks. It was also made into cogwheels, arrows and pestles. The 17th century diarist, John Evelyn, wrote about the wood in his book *Sylva*. It was, he claimed, 'of so hard a substance as to make wedges to cleave other woods with, instead of iron.'

Dogwood produces almost pure charcoal when heated in the right conditions and so was used for making high quality gunpowder, which is a mixture of saltpetre, sulphur and charcoal.

The berries also had their uses, despite their bitter taste. They contain a fair proportion of oil and, in the days before paraffin was widely available, they were boiled down to produce lamp oil. Their oily quality accounts for the Welsh name for dogwood, 'cwyros', which means 'wax bush'.

Among their other former uses, dogwood berries were an ingredient in soap and, medicinally, they were used as a natural form of laxative.

Above: In late autumn, dogwood leaves turn reddish-purple just before falling, becoming one of our most distinctive shrubs at that time of year.

Common dogwood (*Cornus sanguinea*). Native deciduous shrub found mainly in southern and central England, especially on downlands. Height to 4m (12ft).

Below: The fruits mature into glossy black berries just before the leaves turn colour (here they are just on the verge of doing so). To us, the berries taste extremely bitter though birds readily eat them, shedding the seeds in their droppings.

FAR-AWAY PHALAROPES

Phalaropes are rare birds with the unusual distinction of having reversed sexual roles: the females are brightly coloured, and the duller males hatch and raise the young.

Above: A male red-necked phalarope incubating. It is less conspicuous than the female, whose red plumage extends down the neck.

Red-necked phalarope (*Phalaropus lobatus*); summer visitor; female 20cm (8in), male smaller.

Grey phalarope (*Phalaropus fulicarius*); migrant; female 20cm (8in), male smaller.

Wilson's phalarope (*P. tricolor*); accidental; female 23cm (9in), male smaller.

There are three species of phalarope: the red-necked, the grey, and Wilson's phalarope. Although they are classified as waders, these birds spend much of their time swimming. They have wide lobes on their toes, as do grebes and the coot, and it is these that make them such efficient swimmers. Two of the species (the red-necked and the grey) spend the whole of the winter far out in tropical oceans–an astonishing feat for such delicate-looking birds.

Birds of the island fringe Of the three species of phalarope only one, the red-necked phalarope, breeds in Britain and Ireland, and even this has only a slender foothold, with perhaps 50 pairs breeding each year. However, this is not surprising since, in both the Old and the New World, they prefer to breed in the treeless tundra zone, between latitudes 60° and 70° north. Thus mainland Britain is well to the south of their main breeding range; only the Shetland Isles are sufficiently far north. Despite this, red-necked phalaropes also breed on the Orkneys, Hebrides and on the west coast of Ireland. They are loyal to traditional breeding colonies, but several colonies, after an existence of many years, are now in danger of extinction. Indeed, there was once a colony in Ireland with 50 pairs or more, but fewer and fewer phalaropes returned each year until, in 1972, no pairs bred there at all.

Efficient breeding The most remarkable characteristic of all species of phalaropes is the way they divide nesting duties between male and female–for they are among the tiny minority of birds with reversed sexual roles. In most species of birds, the male sings and displays in order to claim and defend a territory and attract a mate; often he takes only a minor part in nest-building, incubation and caring for the young. He is more aggressive, and has more striking plumage than his mate.

The female phalarope, on the other hand, is larger and more brightly coloured than the male; she sings and displays, lays the eggs and then leaves incubation and caring for the chicks entirely to her mate. The male, in keeping with his more secretive role, has dull, well-camouflaged plumage.

The phalarope's breeding system is a beneficial adaptation, enabling each pair to raise the maximum possible number of young each year. At their Arctic and sub-Arctic breeding grounds, the summer is short and cool: speed and economy of reproduction is essential. For the adults, egg-laying and incubation are the most difficult, energy-sapping tasks (the chicks are largely self-sufficient). Many waders share the incubation, thus reducing the burden on the female's meagre reserves, but the phalarope's method, where only the male incubates, allows the female to recoup her lost energy reserves unhindered, often gathering with others on nearby pools. The only other British bird to

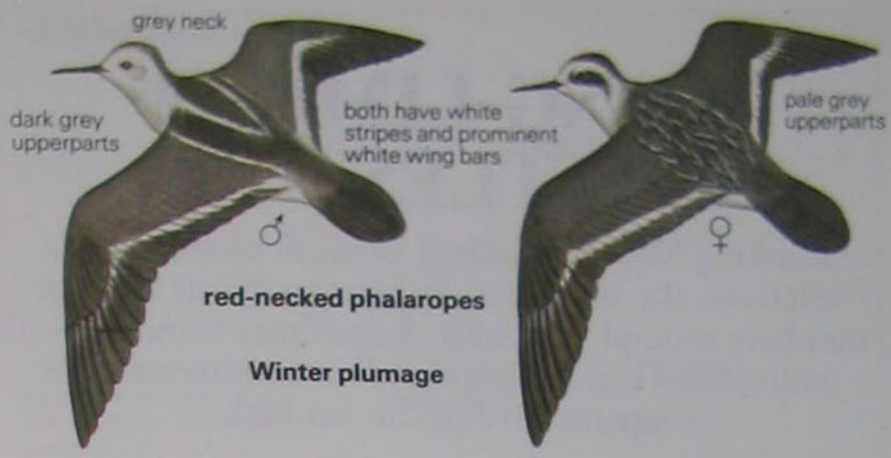
adopt this strategy is another wader, the dotterel, which breeds on high mountain tops in Scotland.

Nesting in marshes Red-necked phalaropes are among our latest spring migrants. The earliest birds, usually females eager to claim the best territories, arrive in mid-May–a time when some of our resident lowland waders already have their first brood of chicks–while the latest may not appear until mid-June.

They have a variety of calls, of which the most distinctive is the female's trilling 'chip, chip, chip, chip', uttered during her display flight. Her plumage is decorative: white throat and underparts, slate-grey head and upperparts, and a bright orange-red stripe down the side of her neck, from which the name of the species derives. Both wings and back have buff-coloured markings forming, in a rear view, a double V shape. The male is browner and duller and his red neck-stripe is less extensive.

Wet, marshy areas with scattered, reedy pools, often only a few metres wide, provide ideal habitats for breeding phalaropes; they feed on the pools and nest among nearby tussocky grass. Some use bays and inlets of large inland or seaside lochs.

Both sexes scrape nesting hollows in suitable well-hidden spots, and in one of these the female lays her eggs–usually four in number. Like those of many ground-nesting birds, their eggs are well camouflaged, being buffish and irregularly blotched with brown.



Left: The grey phalarope breeds in the Arctic zone, in Siberia, North America and on some north European islands. It is sometimes seen in Britain, on passage to its summer haunts in the tropical Atlantic. Wilson's phalarope, the third species, breeds only in North America, and a mere handful are seen in this country in autumn, blown off course across the Atlantic.

Below: A pair of red-necked phalaropes–the female is on the right.

Phalaropes are sometimes polyandrous–that is, the female (since she is freed from further parental duties) is sometimes able to find a second mate. By making a second nest, often only a short distance from the first, and laying a second clutch, she can double the number of her offspring without spending any more time in the breeding grounds.

The phalarope chicks hatch after about 20 days. Their first coat of down provides marvellous camouflage, as it is striped and mottled with various shades of yellow, brown, black and white.

And so to sea With the arrival of autumn, phalaropes leave the icy waters of the north to head south, and many pass along our coasts. A combination of their slim build, needle-fine bill, swimming habit and a conspicuous black mark through the eye is sufficient to distinguish them from other waders. At a distance and in flight, they have a noticeably white head and a large white wing bar.

The wintering range of our phalaropes is poorly known; much of their time is spent out of sight of land. However, red-necked phalaropes are seen in the tropical regions of all three southern oceans–the Indian, Pacific and Atlantic–and our birds probably winter off the coast of West Africa, 8000km (5000 miles) south of Scotland.

Spinning on the water In their remote breeding areas, as well as out at sea during winter, phalaropes do not normally come into contact with people, and perhaps as a result of this they are surprisingly tame: they allow very close approach without showing any sign of concern.

Occasionally they feed on land, trotting over seaweed washed up by the tide, for example; but they prefer to wade–or, better still, swim. They have the amusing habit of swimming in tight circles, or even spinning like a top, creating a little whirlpool which stirs up the water and underlying sediments, and brings food to the surface. As well as insects, they eat tiny snails and worms, and a variety of marine organisms.

LONG-LIMBED BRITTLESTARS

Looking like long-limbed versions of their close relatives, the starfishes, brittlestars occur in huge numbers around our coast. Sometimes thousands of individuals can be found crammed into a single square yard of the sea-bed.

Brittlestars belong to a group of marine animals called the echinoderms, along with other, more familiar, creatures such as starfishes and sea-urchins. Brittlestars resemble starfishes closely – both have five arms radiating from a central body – but on brittlestars the arms are much more clearly demarcated from the body and they are longer and thinner, even snake-like. Indeed, the zoological term for brittlestars, the ophiuroids, comes from the Greek for snake, 'ophis'. Their common name refers to the fact that the arms are brittle and break off easily.

Like the other echinoderms, brittlestars are exclusively marine. They may be found under stones and among seaweed at low tide

but they are far more common below the intertidal zone. Here, they often occur in enormous numbers, either on the sea-bed or partly buried in sediment. The common brittlestar (*Ophiothrix fragilis*), for example, has been recorded at densities of 2000 per square metre and many underwater photographs show brittlestars to be the dominant organisms over large areas of the sea-bed.

Body structure Depending on the species, the central body of a brittlestar may be circular, star-shaped or pentagonal. The upper surface is covered with tissue which often extends between the five arms round to the underside, where the mouth lies. The enveloping tissue does not quite reach the arms themselves. Instead, it stops short, leaving slits between the sides of the arms and the central disc. These slits are called genital or bursal slits and they lead inside the body to thin-walled sacs called bursae, which act as gills and are also associated with the reproductive organs.

The arms are jointed and can bend in the horizontal plane, but not vertically. Each arm contains a series of bone-like ossicles joined together in a row, in a similar manner to our own backbone. In extreme cases, fractures can occur between ossicles, allowing the arm to break in two and providing the brittlestar with a useful means of escaping when caught.

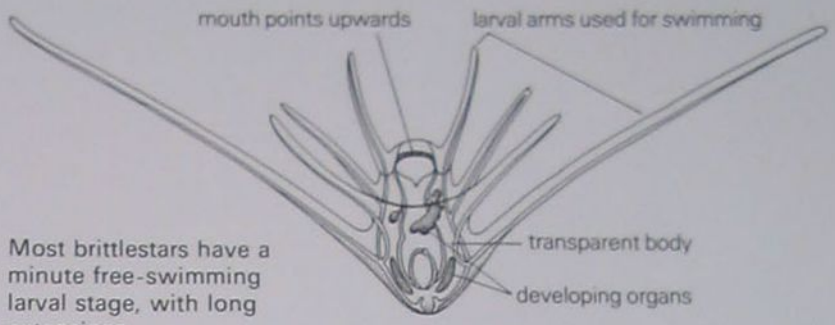
Each ossicle is surrounded by four shields – one above, one below and one on each side – giving the arms a jointed appearance, though this is not always obvious in species where the arms are covered by tissue. Each of the side shields usually has between two and fifteen spines emerging from it – the arrangement and number of these spines is often an important clue to identifying different species.

Arms for moving and feeding Brittlestars use the sinuous bending of their arms to move along. Usually, the central disc is held above the substratum and, while one arm trails or leads, the other two pairs thrust the brittlestar forward in a rowing action. Less active brittlestars tend to extend one arm, wrap it round a stationary object and haul the rest of the body along. Other species, however, can climb and some even manage to swim jerkily.

An equally important function of the arms is feeding. This is accomplished by means of suckers called tube-feet that protrude between the shields on the arms. These tube-feet are similar to those on the underside of a starfish's arm, but in the latter case they are used primarily for movement, whereas on the brittlestar they are used to collect food material and transfer it to the mouth. Only occasionally are they used to provide some purchase on the substratum, for example, when climbing.

Although some brittlestars are scavengers, most feed on small particles of detritus. Some feed by using their tube-feet to sort out and pick up particles lying on the sea-bed, while

A brittlestar larva

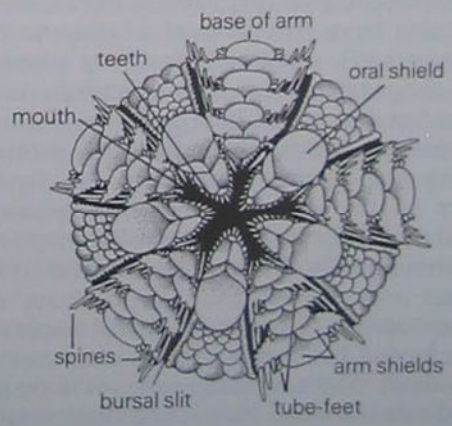


Most brittlestars have a minute free-swimming larval stage, with long extensions.

Above: The underside of *Ophiura texturata*, one of our few burrowing brittlestars, clearly showing its star-shaped mouth. The upper surface of this species is orange-brown.
The underside of a typical brittlestar is shown on the right.

Opposite left: A dense colony of common brittlestars on the bottom of Strangford Lough, a saltwater lough on the east coast of Northern Ireland.

The view from below



Above: *Acrocnida brachiata* burrowing into sand. This species has extremely long arms—from tip to tip it can measure up to 40cm (16in) across.

others filter-feed by holding up one or more arms and trapping drifting food particles on their tube-feet or between the spines on their arms. The tube-feet, with the assistance of small hairs called cilia, pass the food along the arms to the mouth. The first one or two pairs of tube-feet closest to the mouth act as taste organs as well as helping to select and pass along food, and they are sometimes found well inside the mouth.

The mouth is shaped like a five-pointed star, the five inner projections being known as jaws because they are lined with ossicles acting as teeth. The mouth leads into a large sac-like stomach, but there is no intestine or anus, and indigestible material has to be voided via the mouth.

Separate sexes In most species of brittlestar males and females form separate individuals. Reproduction usually occurs by either eggs or sperm being released through the bursal slits into the open sea, where the eggs are fertilised.

As with other echinoderms, the adults are bottom-dwelling yet they develop from a free-swimming larva. The larva of a brittlestar is microscopically small and consists of a body with long extensions. The extensions are covered in cilia which beat to create feeding currents and to drive the larva along, so dispersing the species. Eventually the larva settles on the sea-bed and metamorphoses into the adult form. The young adult may not become sexually mature for another two years.

Some species of brittlestar are hermaphroditic, having both sexes present in the same individual. These species may not have a larval stage; instead they brood their young in their bursae. When their young emerge, they look like replicas of their parent.

As well as sexual reproduction, some brittlestars are capable of reproducing themselves asexually by dividing into two.

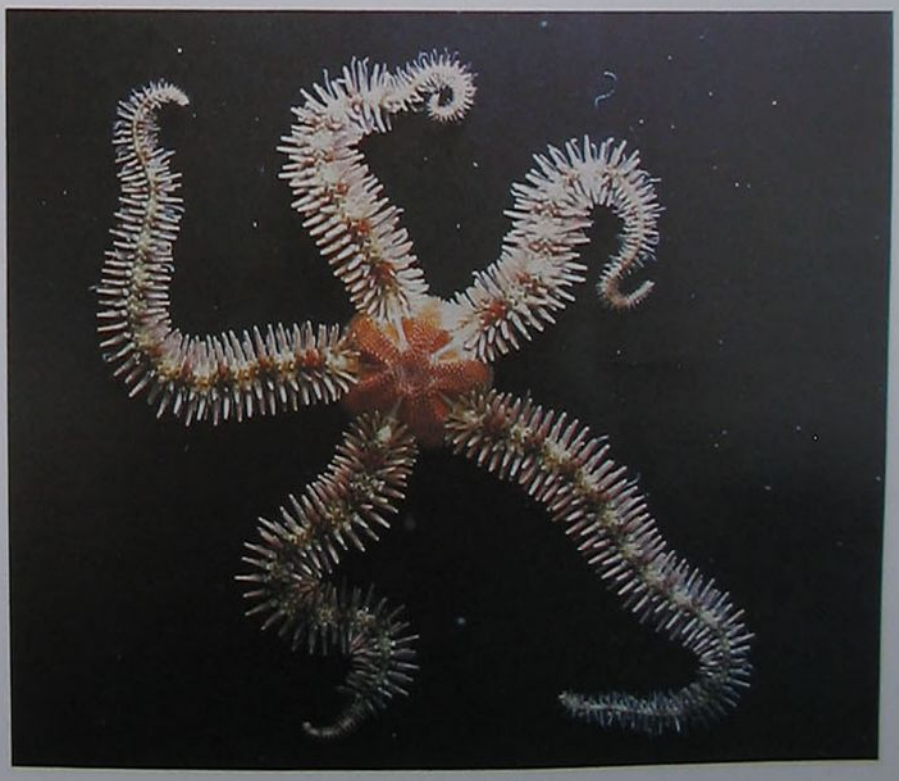
British brittlestars Worldwide, there are about 2000 species of brittlestars, of which approximately 100 can be found in British waters. The most common species is *Ophiothrix fragilis* which, as its specific name indicates, is very fragile and often seen with arms regenerating. Like many brittlestars its colour is variable, ranging from white to brown, red or even violet. The disc is about 2cm ($\frac{3}{4}$in) in diameter and each arm is about five times as long as that. It can often be found under stones or among seaweed low down on rocky shores and is common on the sea-bed.

Another species often found associated with *Ophiothrix fragilis* on the lower shore is the small brooding brittlestar (*Amphipholis squamata*). This species, one of the few hermaphroditic brittlestars, is blue-grey in colour and only a quarter the size of the common brittlestar.

Another species, *Acrocnida brachiata*, burrows into the substratum at the bottom of sandy shores. This brittlestar is distinguished by its extremely long arms, which may be up to 15 times as long as its disc diameter. As the disc is 13mm ($\frac{1}{2}$in) across, each arm is therefore about 20cm (8in) long. It burrows into the sand to a depth of about 10cm (4in), leaving just the end of one arm above the surface to catch food particles drifting by.

One of the larger British brittlestars is *Ophiura texturata;* it has a central disc about 3cm ($1\frac{1}{4}$in) long and arms four times longer. It, too, burrows in the sand from the lower shore downwards and is sometimes found washed up on the upper shore.

Below: All brittlestars have spines on their arms but on the common brittlestar they are particularly noticeable. The spines help to grip the substratum during movement.



THE FLOWERS OF UPPER TEESDALE

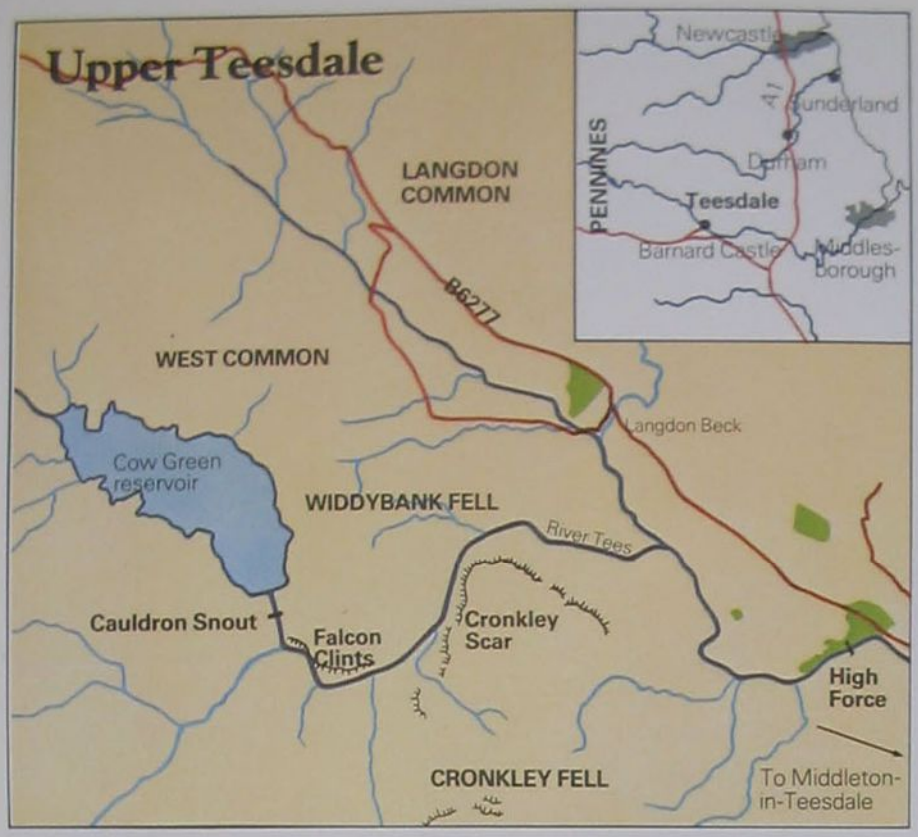
The hills and valleys around the source and upper reaches of the River Tees in the Pennines, famous for their strange assemblage of rare and local plant species (such as the Teesdale violet), are fascinating to botanist and ecologist alike.

Above: Falcon Clints in Upper Teesdale, with Cauldron Snout (the famous waterfall) visible at the bottom left. This area provides scientists with a perfect opportunity to research the history of Teesdale's unique flora.

The curious geographical affinities of Teesdale's assemblage of plants are intriguing: there are Mediterranean plants at the north of their range; arctic species at their southern limit; arctic-alpines; and plants with an eastern continental distribution. All grow together over a relatively small area.

Upper Teesdale has long been known to botanists as a source of rare plants, but the area only came into prominence as a nationally important biological site when plans were announced for building a reservoir over a large part of the most botanically rich area – Cow Green. After protracted wrangling, permission was granted, and the reservoir was built in the late 1960s, with the consequent loss of part of the best area. However, interest in Upper Teesdale had been stimulated, and neighbouring universities increased their programmes of research into this unique area. At about the same time, the Nature Conservancy Council negotiated a nature reserve agreement over a large section of the remainder of the upper dale, giving it a degree of protection from agricultural and industrial change.

As a result of this activity, the composition of the extraordinary 'Teesdale assemblage' of plants is now adequately known, and the reasons for its existence are better understood, although it is surprising how recently many of the rare species have been discovered. For example, rare spring sedge was discovered



Above: A map of Upper Teesdale. Today much of the area is a National Nature Reserve, by agreement with the owners, although there are still problems with its conservation. Agriculture and grouse-shooting continue within the reserve; the sugar limestone is being eroded away gradually by wave action from Cow Green Reservoir; and there are now over 50,000 visitors every year to the reservoir area, which causes problems too. In spite of these problems, however, the future of this internationally important site looks reasonably secure.

in Teesdale in 1945, alpine foxtail grass in 1959, and the dwarf birch in 1965, in what was then its only locality in England and Wales. Since then, the northern water sedge has been found (1972), and a very rare arctic-alpine moss (1975). The quantity and range of rare or out-of-place plants now known from Upper Teesdale, totalling perhaps 130 species, is remarkable.

A look at some rarities Many of the species are arctic-alpine or arctic-montane plants – that is, they are confined to the Arctic and to the higher mountain masses outside the Arctic. Some of them occur just within northern Europe though others are more widespread. Among the species of this type to have persisted in Teesdale are the Scottish asphodel, alpine forget-me-not, mountain avens, alpine bartsia and hoary whitlow grass. The alpine foxtail is arctic only, right round the globe, and finds almost its southernmost world locality in Teesdale. Some, like the hoary rockrose, are fairly widespread in Europe, but reach their northernmost British locality in Teesdale, while another group occurs mainly in eastern Europe – the rare spring sedge, for instance, which reaches its westernmost and highest locality in Teesdale, and the Teesdale violet, which occurs in only three places in Britain. Other species, such as horseshoe vetch which is predominantly a south European plant, find their northernmost world locality here, and the bitter milkwort has a similar distribution. Finally, there are the beautiful spring gentian, which occurs only in Teesdale and western Ireland within the British Isles, and the Teesdale sandwort which occurs nowhere else in Britain.

This is, indeed, a very odd collection of plants. They do not, however, all occur in any one place. The patches of sheep-grazed grassland, for example, support the best populations of the spring gentian, while even rarer species like the bitter milkwort and the Teesdale violet are virtually confined to such places. There are small patches of eroding 'sugar' limestone in Teesdale and here the hoary whitlow grass and mountain avens occur. Other species, such as the alpine forget-me-not and the alpine foxtail, occur only on the highest mountains, the first on limestone cliffs and the second in wet flushes right at the head of the valley.

Above: The beautiful spring gentian, with its startlingly blue flowers, occurs only in Teesdale and western Ireland within the British Isles. Patches of sheep-grazed grassland support the best populations of this species.

Right: Sugar limestone at Widdybank Fell in Upper Teesdale. This strange, friable rock, known more correctly as saccharoidal marble, gives rise to thin soils which erode easily and drain freely. Many of Teesdale's rare plants grow on this soil.

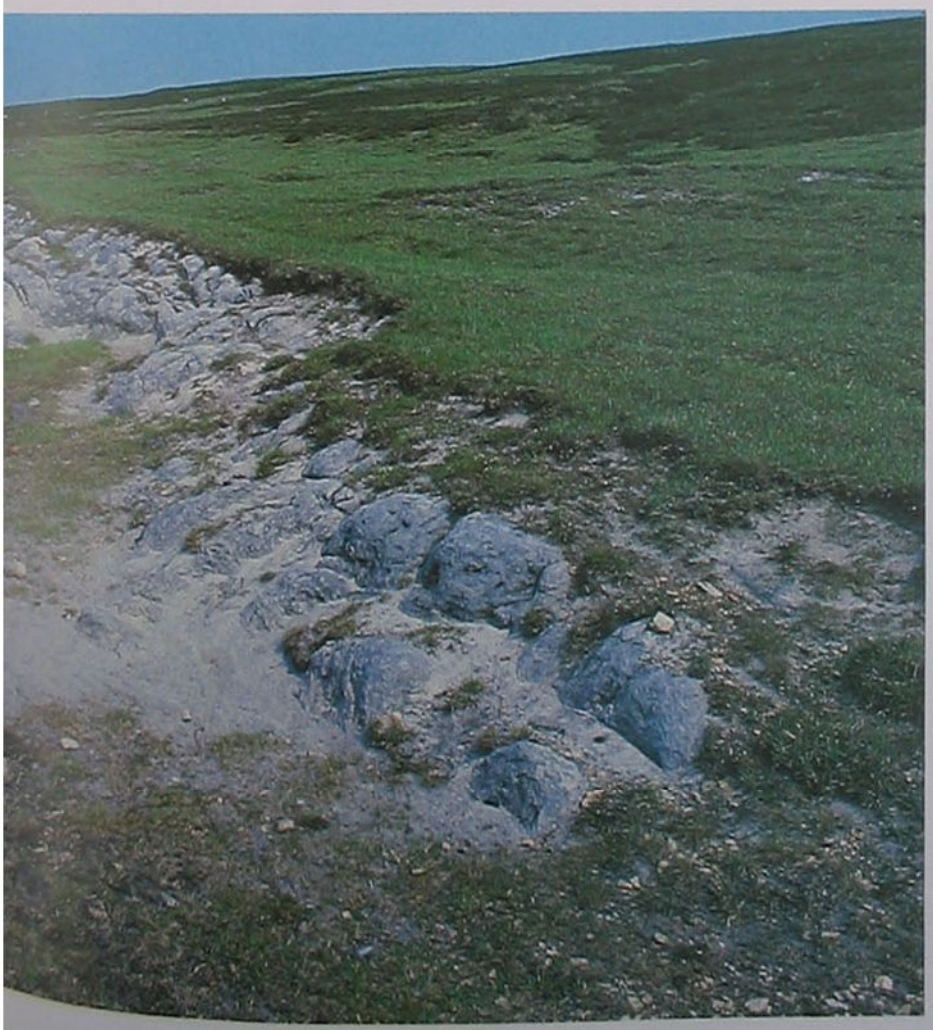
Reasons why For a long time the reasons for this concentration of plants were unclear. It was thought that many of Teesdale's high areas were relatively free of ice during the last glaciation and, some 50 years ago, a theory was put forward that the plants may have survived in ice-free areas (known as 'nunataks') from the flora that existed *before* the last Ice Age. It is now known more or less certainly that, in fact, the whole of Upper Teesdale was buried under ice until about 10,000 years ago, and this, together with other evidence, has led to the evolution of another and much more compelling theory.

As the ice retreated from its maximum extent in central southern England, the flora that had survived in areas close to the ice (the 'periglacial' area) was able to colonize the newly bared areas. As Teesdale was gradually exposed it became colonized by periglacial flora and we now know, from pollen analysis and other remains elsewhere, that this periglacial flora did indeed include many of the species that now occur in Teesdale.

This is not, however, the full answer. First, what are plants with a southern distribution – like horseshoe vetch, which could probably never have survived anywhere near an ice cap – doing at their highest and northernmost locality? And secondly, why does this particular collection of plants occur only in Teesdale? The answers lie in Teesdale's unique position and structure. The Teesdale flora

Above: Hoary rockrose is one of the species that, although fairly widespread in Europe, reaches its northernmost British locality in Teesdale.

Right: Quite a find in Upper Teesdale – Alpine bartsia, one of the arctic-alpine species that survives in this area.



can be viewed as a 'relict' of the periglacial flora that has persisted to the present day, but it is not an exact replica of that glacier-edge flora, for the climate has warmed considerably and then cooled again since the last Ice Age, and Teesdale has acquired and retained other species from these times. The horseshoe vetch, for example, must have arrived at a time when the weather was much warmer than it is now.

The reasons why similar relict floras have not survived elsewhere in England, to anything like the same extent, are attributable to three main factors. First, virtually all of England has been covered by more or less dense forests at some time or another, the trees consequently shading out or outcompeting the early flower colonizers; secondly, a blanket of peat has covered much of the British uplands during periods of high

Above: There is not much insect life in Teesdale because of the fairly high altitude—but you may see a painted lady butterfly migrating through.

Left: The Teesdale violet occurs in only three localities in Britain—so if you find one, don't pick it! In the valleys of Teesdale even the hay meadows have their own special plants: for example, three species of lady's mantle, which occur only here and in the adjacent dale.

Below: A golden plover and its nest. This species can be found on Teesdale's high grassland and moorland.

rainfall, causing conditions quite unlike those that existed just after the ice retreated; and thirdly, man's activities have inevitably affected the flora as the land has been cleared, ploughed, burnt, built on or grazed. Virtually all of England, and most of Scotland and Wales, have been affected by these factors so that now, in most places, there is no evidence on the surface that a periglacial flora ever existed.

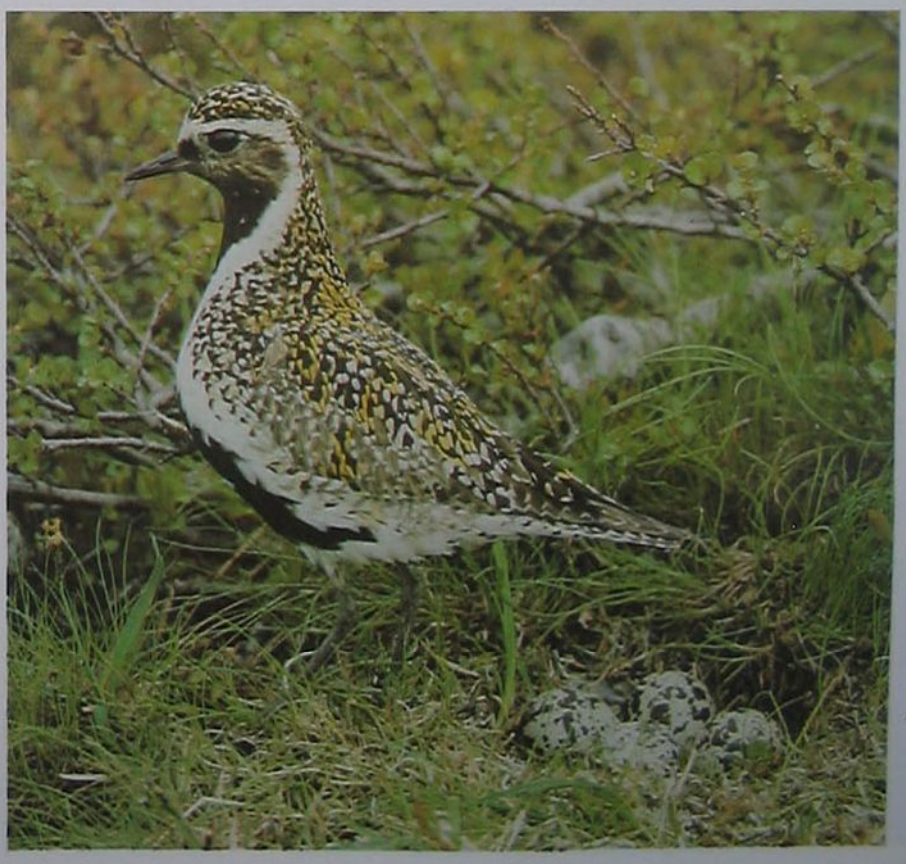
Teesdale as a plant refuge It has become clear that certain areas have acted as 'refuges' for a variety of plants because they have escaped the changes described above.

Almost all the situations that can give rise to refuges occur in Teesdale, including areas that have always been above the tree line (ie mountain tops), river gorges and shingle, inland screes and cliffs, marshes and flushes, and shallow soils over limestone. The presence of all these features, combined with a notably cold climate and a nutrient-poor soil (both reduce the growth of competing species), provide all the factors necessary to explain the survival of so many species.

One feature, however, requires further explanation because it alone accounts for the presence of many of the Teesdale rarities and it is a unique feature within Britain. When the Great Whin Sill was intruded, in a period of volcanic activity, as hot magma (semi-molten material under the earth's crust) into the Carboniferous limestone of the upper dale, it baked and changed all the limestone with which it came into contact, turning it into marble. (The Great Whin Sill is a formation of igneous rock, known as whinstone, which runs for some 70 miles across the north of England.) Because of the peculiar characteristics of the limestone, and various other factors, it did not turn into solid marble but into a strange sugary friable rock, generally known as 'sugar' limestone. This limestone gives rise to very thin soils which erode easily and drain freely, have a very high lime and heavy metal content, and are very poor in nutrients. Neither trees nor blanket bog can flourish in such conditions, and it is here that, in consequence, the majority of rarities survive.

Insects and birds The peculiar conditions of Teesdale have best suited the survival of plants, although it is becoming clear that a number of rare invertebrates (including two species of bloodsucking blackflies, and a sawfly that are new to science) also occur in Teesdale. But to the casual visitor it may well appear that there is no insect life at all.

Bird life is rich in the dale, although it is not greatly different from other parts of the Pennines. The presence of the large Cow Green reservoir gives an added dimension to the habitat. You can expect to see golden plover and dunlin breeding on the high grassland and moorland, oystercatchers by the river, and yellow wagtails in the meadows.



THE BROWN HARE'S STEADY DECLINE

The brown hare has always caused controversy. It is a secretive, nocturnal animal that is hard to observe and even more difficult to understand. One thing is certain, however: although its numbers are slowly dwindling, it is still far from extinction.

The brown hare is a wild, paradoxical animal. Its natural history is somewhat mysterious and the subject of much disagreement among scientists. One thing is undisputed: today the hare is suffering a major decline in numbers– the shooting returns from about one and a half million acres of land show that over the last 20 years three-quarters of its population has apparently disappeared.

The hare's decline, like its natural history, is causing widespread controversy, prompting press reports suggesting that it will follow the otter towards extinction if the Government does not act soon to ban its hunting. Certainly numbers have dropped substantially, but it is alarmist to suggest that the hare is anywhere near extinction. There is also little foundation for the suggestion that the hare's present plight would be helped by a reduction in shooting, hunting or coursing. The picture is actually much more complex.

Recent research The story emerges from a research project on the hare by Stephen Tapper and Richard Barnes of the Game Conservancy at Fordingbridge, Hampshire. They believe they have begun to identify some of the reasons for the hare's decline. It reflects changes in agricultural methods and indeed the complex pattern of the English countryside itself.

The decline is difficult to quantify, because no one has ever made a count of hares throughout Britain. The best evidence comes from the records of shooting bags from 400 to 600 estates and shoots in Britain. Even so, bag records are only indirectly related to hare density, because only when hares are numerous do sportsmen go out to shoot them. A bag of zero for a year does not mean that there are no hares in an area, but suggests that they are thin on the ground and were thought to be not worth shooting.

Above: The brown hare. Research shows that natural mortality is around 50% for each age class: that is to say, a hare has an even chance of survival during its first year, the same for its second year if it lives that long, and so on. Statistics show that shooting does not have a significant effect on annual mortality above the level already established by disease, starvation or predation. A reduction in shooting would not significantly improve the hare's situation.

Above: A leveret in its form. Young hares and leverets are taken by a large variety of predators, including buzzards, stoats and weasels. Crows and magpies also tackle leverets if they get the chance.

However, the general trend of bag records indicates that the hare population of Britain has declined steadily, at least since 1962. In 1961-2, twelve to fifteen hares were shot per hundred hectares (250 acres). In the last two or three years, on average, only five were shot per hundred hectares. The decline in East Anglia has been particularly sharp, though all areas have been affected.

Pesticides and herbicides have been blamed for the decline of many species of British wildlife. They may be a factor in the hare's demise, but probably not a major one. Hare numbers started to decline before chemicals lethal to hares, such as paraquat, were used.

Tapper thought that climate might have had something to do with the decline during that period: perhaps a series of poor summers might have affected crop production, or a succession of wet springs combined with poor summers might have caused high leveret mortality. But examination of meteorological records could not account for all of the decline. If anything, the decrease seemed to correlate with a reduction in the amount of arable farming. Shooting did not seem to be a factor, either. As a result of this early work, Tapper believed that the key to today's hare decline lay in the changes of agricultural land use, although he did not rule out other factors.

To discover why an animal is declining it is necessary to observe it in the field. Hares are not easy to watch–quite the reverse in fact. For although they reveal themselves quite openly during the 'mad March' period, for the rest of the year they are secretive and mostly active at night. In summer they disappear in the fields, hidden by the long corn and grass. At other times they take cover in hollows and hedgerows. Even when they are out in the open, their camouflage is so good that they can escape the human eye if they stay still.

Radio-tracking experiments Barnes and Tapper attached small radio collars to their study hares. It is generally thought that hares live out in fields in all weathers, feeding at night and lying down in the open during the day, crouching in their forms, with their backs

Below: Avian predators of the fully grown hare are the golden eagle and the goshawk, although they are both extremely rare.

to the wind. But the radio transmitters revealed that in the study area in winter this was not wholly true: the hares were taking refuge in thick woodland during daytime. The probable reason was that this was the only cover available. Now that farmers have pulled out so many hedgerows and untidy areas of scrub from the corners of fields, hares are forced to shelter away from their feeding grounds. This can only be detrimental, since travelling to and fro burns up energy. The lack of cover in agricultural areas today may be an important factor in the demise of the hare.

Further research through the seasons revealed that in spring the hares spent 70% of their time in young cereal crops, which would seem to be an ideal food for them. However, in summer they abandoned the longer wheat and barley and spent much more of their night feeding hours in the grass leys and pastures. It appears that hares disdain crops when they grow longer, preferring shorter weeds and grasses.

New studies on a farm in Wiltshire may confirm this. Here corn is grown organically, without the use of chemicals. As a result corn yields are reduced and the weeds are more common in the fields. It will be interesting to see whether hare numbers eventually increase on this farm as a result of the greater abundance of weeds.

Today's economic climate dictates that not only are weeds eliminated but that each field must produce its maximum profit. Crop rotation used to include several years of ley grass, but now oilseed rape or beans are often planted instead as a break crop, and grassy habitats for the hare are becoming scarcer.

Stubble burning is another modern phenomenon that is unhelpful to hares. It may cause the death of young leverets and, most importantly, it burns the weeds in the stubble. To add insult to injury, many farmers are now burning and ploughing in the stubble within a few hours of harvesting, so on an arable farm there is little to eat in autumn until December when winter wheat comes up.

Natural enemies As far as natural predation goes, the brown hare has few enemies when fully grown. It is a powerful animal, weighing up to 4kg (9lb), and can run at up to 40mph. It can jink and dodge at speed, so the best form of attack on the hare is surprise – foxes will take hares if they manage to surprise them. In many parts of the country where fox numbers have increased signifiantly in the last 20 years foxes may be making inroads into the hare population.

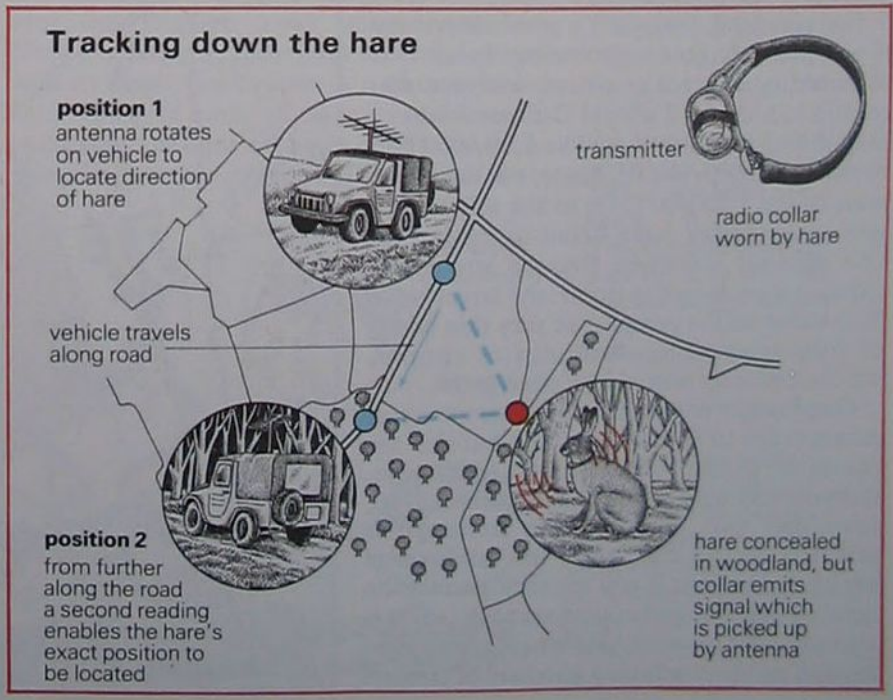
The decline of the hare reflects not predation by animals nor shooting by man, but the changes in agriculture. Old style pastures and meadows, weeds and hedgerows, are being destroyed for economic reasons. And with them, in all probability, goes the hare.

Above: The brown hare – not always easy to spot – can be distinguished from the rabbit by its long, black-tipped ears, long hind legs and larger body size.

Right: A brown hare cleaning its foot. It has long claws which help to give good grip while escaping from predators. Brown hares are usually found singly or in pairs.

Below: Recent research on brown hares on a farm in Hampshire. Radio collars are attached to the animal. The signals transmitted are picked up by a receiver and two intersecting bearings pinpoint the hare's position exactly, by day or night.

Tracking down the hare


position 1
antenna rotates on vehicle to locate direction of hare
transmitter
radio collar worn by hare
vehicle travels along road
position 2
from further along the road a second reading enables the hare's exact position to be located
hare concealed in woodland, but collar emits signal which is picked up by antenna

Above: The author, suitably clad in dark anorak and wellington boots, examining the bottom of a stream in search of specimens. The clumps of bright yellow flowers in the background are kingcups, or marsh marigolds, a common early-flowering plant of damp habitats.

A walk beside your local stream can reveal a great variety of plants and animals – if you know how to find them. Writer and broadcaster Jim Flegg gives us some tips as he takes a walk along some streamside alders.

Reading about natural history is very enjoyable but it does not equip you for actually going out into the 'field' and finding the plants and animals you read about. For this the most important thing is to be well prepared, whether you are going on a whole day's excursion or just a short diversion during a family trip.

First, you will need a good field guide to help you identify what you see. Our walk is in Kent, but the same fieldcraft techniques apply elsewhere in the British Isles, though the plants and animals are often different. Take along two or three guides with you at first so you can choose the one that works best *for you*.

For planning, you need a good map, even if you are only going somewhere local. It is astonishing how many places near you can remain hidden until a local Ordnance Survey map reveals them to you. The 1:50,000 (1¼in to the mile) maps are adequate, but the larger scale of the 1:25,000 (2½in to the mile) maps give considerably more detail to guide you. Our planned excursion through streamside alders is a good case in point: the larger-scale map indicates the presence of very thin bands of trees lying along the banks of streams, which is exactly how alders often grow.

One further point: the map shows not just access roads to your destination, but also the routes of public footpaths and bridleways. But you may wish to break new ground. If so, remember that much of our landscape is privately owned and, while few landowners are likely to object if you ask their permission beforehand, it is still courteous to do so. It is also only fair on your fellow naturalists, who depend on the continuing goodwill of farmers to reach their favourite spots. So the Country Code, with its provisions about shutting gates, controlling dogs, avoiding fires and removing litter, must be observed by us all.

What to wear? Clothing need not be a problem, for the golden rule is always to be warm enough. So take a pullover – it can be quickly removed and stored in a haversack or tied around the waist. A lightweight anorak will protect you from the rain, as well as provide you with a waterproof seat for lunch. For birdwatching, the bright colours of many anoraks are a problem, so choose one that is as dull as possible (preferably green or blue) and try also to find one that does not rustle when you walk.

Footwear is more of a problem on a streamside walk. Wellington boots are often the obvious solution, but many streams are deeper than the average wellington boot. If so, do not be tempted to wade in bare-footed: tetanus thrives in waterlogged areas and all who enjoy the countryside should take the simple precaution of having regular anti-tetanus jabs. The best solution for deep wading is to carry a pair of plimsolls and a towel in your haversack for the occasion.

To the stream We are now ready and equipped. Having planned where to go, just one field away from the road – and with the landowner's permission – we find what we seek. The field of lush grazing grass dips suddenly a few feet to a winding line of alder trees. Their gnarled roots support an earth bank, at the foot of which meanders the stream, only inches wide and an inch or so deep. Having arrived, it is always a good idea to choose a vantage point that is both comfortable and inconspicuous, and settle down to wait and watch.

Our arrival, unless it has been extremely stealthy, will probably have scattered most of

Below: The route of the walk. A large-scale map like this shows important details often lacking in smaller-scale maps. Here, the single row of alders lining much of the stream can be seen, as can the location of small weirs and fords – spots the keen birdwatcher in particular should look out for.

Above: A line of alders flanking a stream, forming a typical alder carr. You'll find that the alder, a small native tree, grows best on the banks of rivers, streams and lakes, though it can also occur a long way from water.

the birds and other animals to safer refuges. They will come back if we sit quietly, but while awaiting their return, there are plenty of other things to see. The streams which are associated with alder usually support a wide-ranging flora. In the stream itself look for brooklime and water forget-me-not. Both these plants have small, pretty blue flowers that appear throughout the summer.

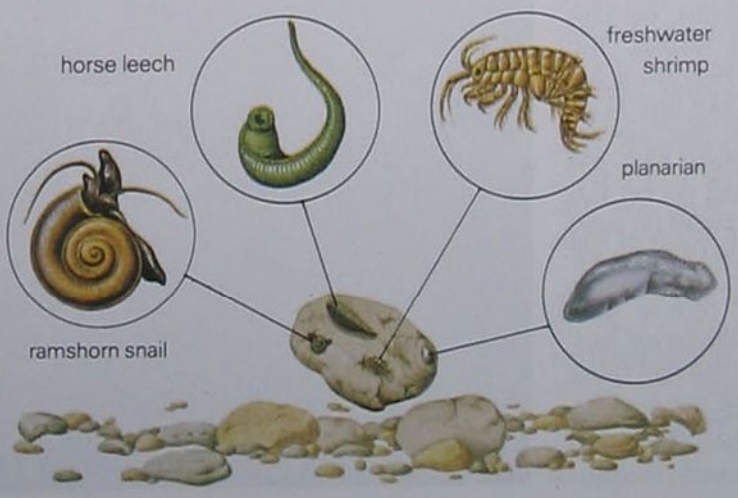
Another conspicuous plant is marsh marigold, growing along the banks in summer. Its yellow flowers measure 1-5cm ($\frac{1}{2}$-2in) across. These are just a few of the plants you may find if you look carefully; there may, of course, be others locally more common.

The absence of its typical call indicates that there are no kingfishers, though rabbits find the bank a suitable home. There are plenty of their small dark round droppings to show us that this is the case and, sooner or later, a startled-looking face will appear at a burrow entrance.

Absolute stillness may reward us with even better views, so sit with your elbows on your knees and binoculars raised in readiness—even the act of lifting your binoculars to your eyes can frighten away many creatures. Slowly it becomes clear that this mini-gorge with its single line of trees is a thoroughfare for a variety of birds, all using it in preference to crossing the open expanses of fields on each side. The wrens, robins and dunnocks that

Life under a stone

The undersides of stones on stream beds are an ideal place for finding small freshwater invertebrates. Common creatures you might see include the ramshorn snail, which can be found in running and stagnant water; the horse leech, a non blood-sucking species; the freshwater shrimp, a smaller version of the more familiar marine shrimp; and a planarian, the most common British flatworm. Use a hand lens to examine your finds.



Checklist of items

1 A pullover for warmth—even in summer; it can easily be stored if not needed.
2 A waterproof anorak, preferably one of a dull colour that does not rustle.
3 Wellington boots for wading. Take plimsolls and a towel for deeper water.
4 A map of the area, preferably 1:25,000 ($2\frac{1}{2}$in to the mile) for extra detail.
5 Field-guide books to help identify species.
6 A pair of binoculars for birdwatching. The best size is 8×30.
7 A hand lens to examine specimens—a suitable magnification is ×10.

Above: Alders provide a popular nesting site for the redpoll, a small linnet-like bird with a distinctive red forehead and a black bib. Look for it drinking or bathing on the banks of streams among the alders.

Left: A pollarded alder stump is quickly invaded by a variety of colonizing plants, here including nettles, grasses and ivy among others. New young alder leaves sprouting lower down will tell you the stump is not wholly dead.

Below: Wild garlic, or ramsons, a distinctive-smelling plant of shady deciduous woodland. There's no difficulty in recognising it—the smell will identify it if you step on the leaves.

are probably resident nearby are joined by various thrushes and tits—and this is a good habitat to get a clear view of the elusive willow tit.

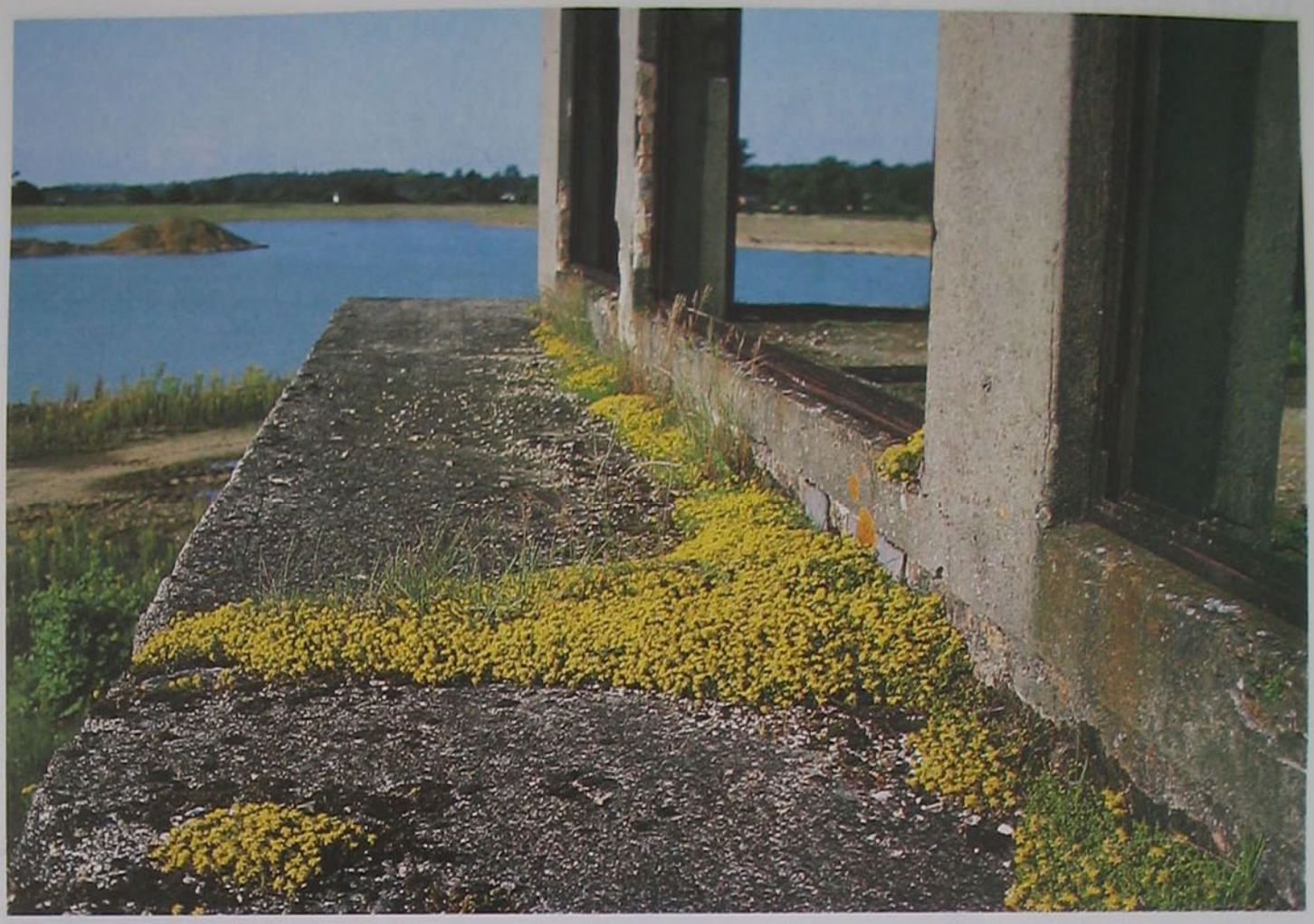
Larger wildlife inspected, it is time to look at the stream itself. No need even to set foot in the water here; just reach out and turn over a stone. Lurking beneath may be a wide variety of small snails and worms, perhaps also shrimps, flatworms and leeches. But don't recoil in horror: the flatworms, a few millimetres long and moving like tiny black slugs, are quite harmless. So, too, are the leeches though they can sometimes be 2-3cm (1in) long. This is where a small pocket lens can be extremely useful, for it reveals far more intriguing detail than the unaided eye can see. If you have forgotten your lens, or don't own one (though you should!), reverse your binoculars and look through the larger lens; it makes a good substitute for the real thing. *Be sure to put the stone back as you found it*; remember that it is security to many tiny creatures.

Moving on As we walk further along the character of the stream changes. The trees are taller, the cover denser, and most birds can be heard before they are seen. This is where you need a good knowledge of bird songs to help you recognise the different species, so you know what to look for. The only sure way to learn all the different songs is by watching and listening, though records of bird songs are a great help at first. An example is the kingfisher, whose shrill monosyllabic calls herald its arrival.

The water is wider and deeper along this part of the stream. Here, we can see the occasional moorhen and mallard moving between the reed mace (bulrush), yellow flag and giant spear-leaved water dock, all growing along the margins of the stream.

This is the part of the stream most likely to hold fish such as trout. Their camouflaged backs make them difficult to see, but with patience you can spot their tails slowly waving as they hold themselves steady in the stream waiting for food. Smaller fish such as sticklebacks move more quickly, and a flash of silver as they turn sideways is a good clue to their presence. Polaroid-type sunglasses will help enormously when looking into water by reducing reflected glare from the surface.

As the stream has opened out, so there is a lot more waterweed floating on the surface. Even in mid-summer these spring-fed streams remain icy cold; the trout may love it, but not the naturalist. So, dip into the water and pull out a handful of weed. Once it leaves the water, the weed subsides from its crisp featheriness to a slimy mound. By far the best way to inspect its structure, and to see the various creatures lurking within it, is to place it in a container of water—a plastic developing dish used by photographers is ideal for this. Again, replace the weed and the animals, when you have finished looking.



A SUCCESSION OF WALL DWELLERS

Older walls may play host to a wide variety of plants, although not all the species establish themselves at the same time. It may take many years before a wall is weathered sufficiently to enable some of the larger flowering plants to take hold.

Above: The brilliant yellow flowers of biting stonecrop provide splashes of colour on walls and stones and a wide variety of other habitats, particularly on chalk and limestone. The succulent, fleshy leaves store water, which enables the plant to thrive in dry areas and where there is little soil. Biting stonecrop is also known as wall pepper because of the hot, peppery taste of its leaves. The star-shaped flowers appear from June to July.

Since most types of the brick, stone and mortar with which we build walls are alkaline, most wall-dwelling plants are species that normally grow on soils rich in lime. Before the majority of such plants can colonize a wall, the stones or mortar must become weathered, forming tiny crevices where the plants can take root. These crevices trap particles of soil and hold water. On drystone walls, which have no mortar, it may be centuries before the hard rocks themselves have weathered sufficiently to allow plants to gain a hold.

Pioneer species The very first life forms to appear on new walls are bacteria and microscopic green and blue-green algae. Tiny algae may appear as a green stain on walls which are frequently wet – near a leaking water pipe for example.

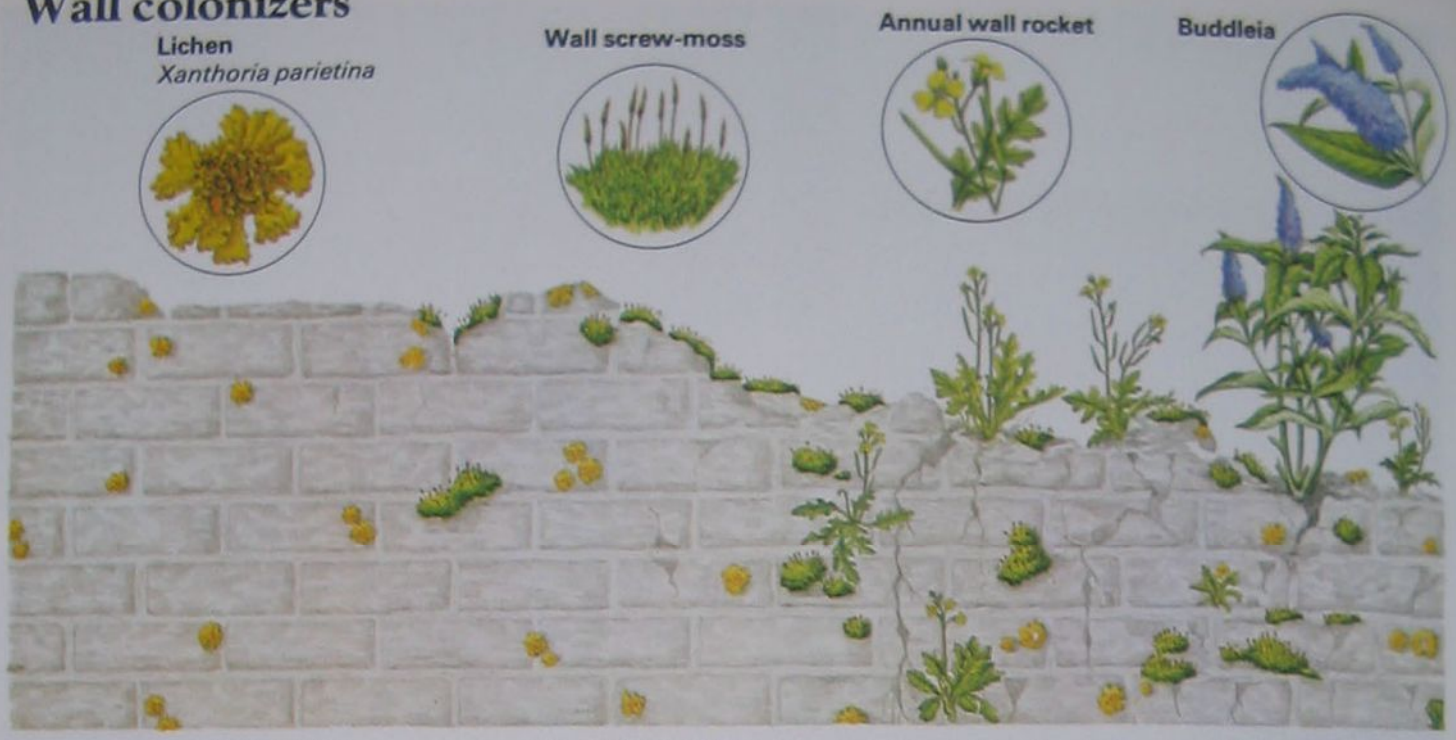
Lichens and mosses are usually the next colonizers. Slow-growing lichens need a stable environment and although they can withstand drought, they are most common on walls in western England where the rainfall is higher. Since they are very sensitive to atmospheric pollution, many species do not grow on walls in cities or industrial areas.

The cushion-forming wall screw-moss is able to establish itself on walls only one or two years old, while the silvery thread moss (*Bryum argenteum*) grows on walls after four or five years. It is common near wall-bases, but is also found on town pavements and on rocks and cliff ledges. It takes its name from its easily recognisable dark, catkin-like stems, which have a silvery lustre.

Ferns such as the wall rue may also be among the early colonizers, although sometimes they are not seen on suitable walls until the walls are about 50 years old. A small fern, wall rue grows on limestone, generally in clefts in shady walls.

Late arrivals The pioneer plants slowly make the wall a more suitable environment for other plants to grow by trapping small soil particles and by speeding up the breakdown of the wall materials to make tiny crevices where other plants can take root. Ivy-leaved toadflax is usually the first flowering species to appear. Annual wall-rocket, a member of

Wall colonizers

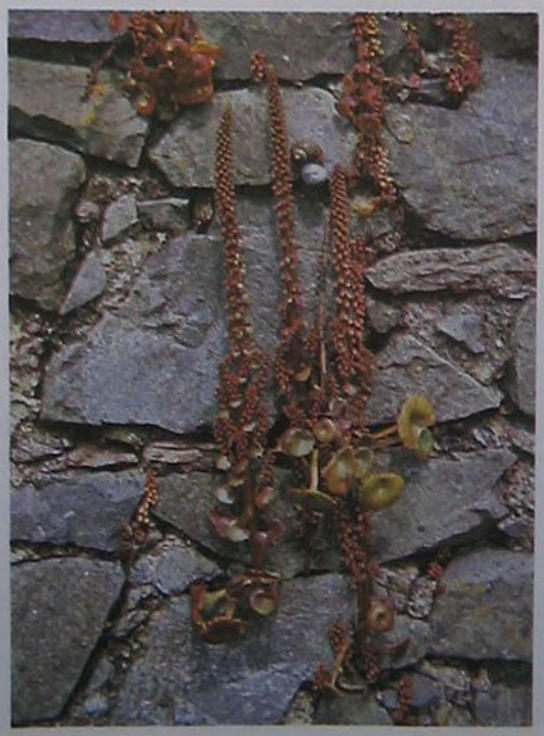


Xanthoria parietina grows on rocks, walls, roofs and trees. An early colonizer of walls.

Wall screw-moss (*Tortula muralis*). Leaves form small cushions less than 1 cm ($\frac{2}{5}$in) high. An early colonizer.

Annual wall rocket (*Diplotaxis muralis*). On waste ground and crevices in older walls. Flowers May-Sept.

Buddleia (*Buddleia davidii*). In parks and gardens and on old walls. Flowers June-Sept. Ht to 5m (16$\frac{1}{2}$ft) – less when growing on walls.



Right, above: The lush green fronds of wall rue (*Asplenium ruta-muraria*) appear in clefts on walls and bridges in shady places.

Right, below: Wall pennywort, or navelwort (*Umbilicus rupestris*), grows between stones or in rock crevices. The flower spikes appear from June to August.

Opposite, above: Red valerian (*Centranthus ruber*) has a strong root which is wedged into rock crevices, enabling it to take hold on rocks, cliffs and old buildings.

the cabbage family, arrives a little later. It is sometimes known as stinkweed, because the juices from a broken stem smell of rotten eggs. Although it usually grows on limestone walls, particularly in southern England, it is also found as a weed on arable or waste land.

Growing conditions The plants that are able to grow on walls must be able to withstand strong sunlight, often with little shade available. Species such as the yellow-flowered sowthistle (*Sonchus oleraceus*), which frequently grows beside walls or on rubble, likes strong light and can survive in a wide range of temperatures. However, the wall lettuce (*Mycelis muralis*) only grows in crevices on rocks and walls where there is some shade during the hottest part of the day.

Dryness is another feature of a wall habitat, since rainwater drains away or evaporates from the surface very quickly. Wall-dwelling species cope with this in a variety of ways.

The stonecrops which grow on walls not only store water in their fleshy leaves, they also grow in tightly packed clumps which reduce the amount of water that evaporates from them.

Wall pennywort, also known as navelwort because of its disc-shaped fleshy leaves with a dimple in the middle, has a swollen stem base or tuber. This is usually lodged in a rock crevice, and provides a store of food and water for the plant.

The leaves of such species as the sowthistle have a waxy outer covering which helps prevent the plant drying out. Other species have the ability to roll their leaves, which also reduces water loss. The rusty-back fern stops growing in dry weather and its fronds curl up, displaying the rust-coloured scales on their undersides, which also help to prevent water evaporating.

Pollution problems Since some species are more able to cope with the dust and grime of city life, walls in towns and cities may support different species from those on walls in country areas. Silvery thread moss seems to show a preference for town walls and wall screw-moss is also tolerant of pollutants in town air. Yew trees, which sometimes grow from walls where birds have discarded the seeds from their fruits, tend to be confined to country walls. Since yews are evergreen, their needle-like leaves are not shed, so absorbed pollutants are accumulated and the tree finds it difficult to survive in polluted areas.

Two lichens particularly resistant to pollution are common on town walls. The crust-forming lichen *Lecanora dispersa* is found on limestone rocks and walls, where it looks like a dark grey-green stain on the wall, with fruiting bodies like tiny jam tarts with brown centres.

Xanthoria parietina is easily recognised as it appears orange in bright light, or greeny-yellow in shade. It grows in 'leafy' patches on the surface of the wall, and is common on acidic rocks and stones, particularly where there are bird or animal droppings, as on the tops of walls, on roofs, or near farm buildings.

Garden escapes Some of the species most commonly seen growing on our walls were once introduced to British gardens, but have become naturalised. Since many of these species grow naturally on dry, rocky ground, they adapt easily to growing on walls.

Red valerian, introduced into English gardens from the Mediterranean in the 16th century, is now naturalised on walls, cliffs and banks. It is spread by seeds with feathery parachutes that are dispersed by the wind and lodge in rock crevices.

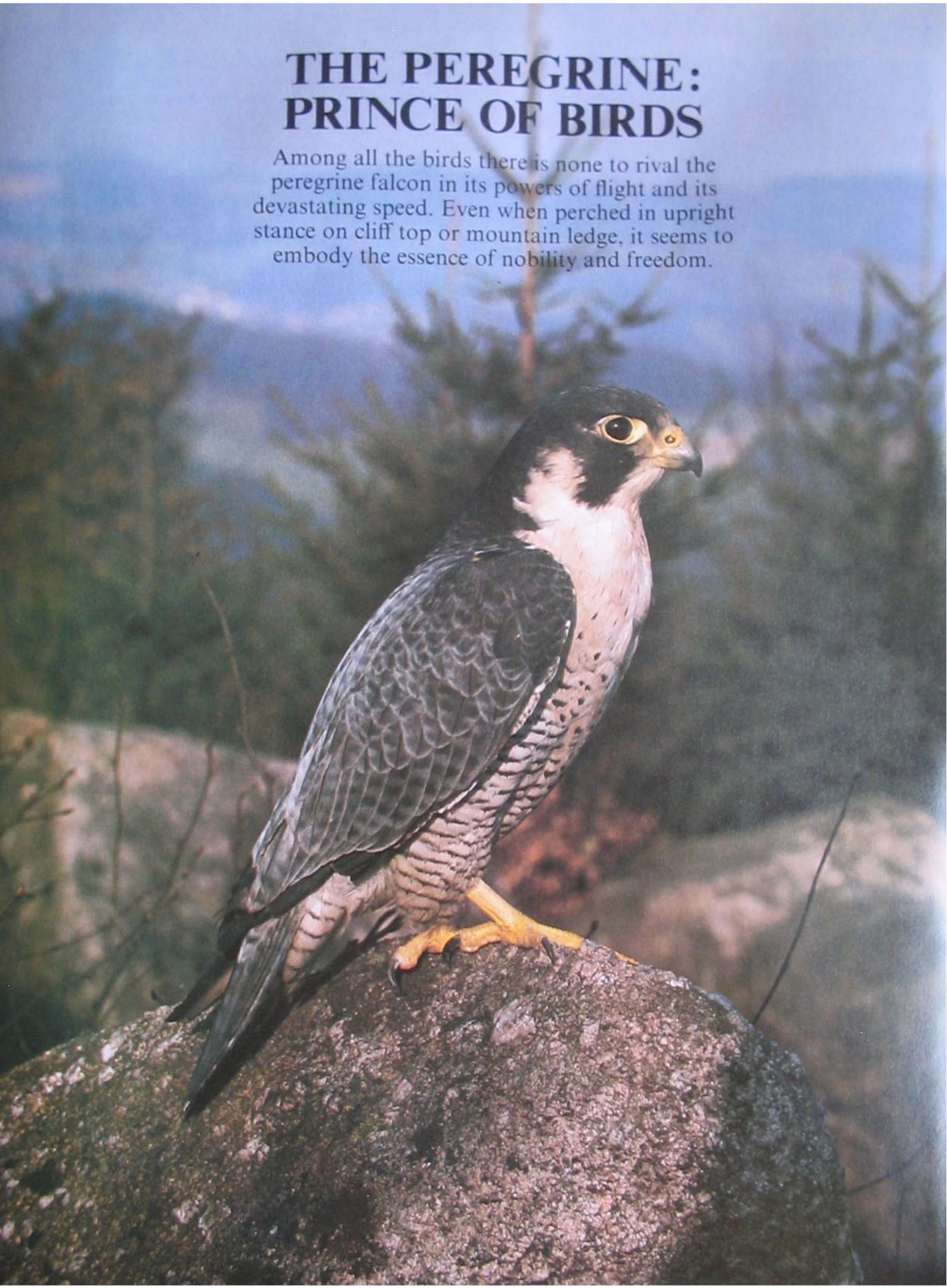
Buddleia is another garden plant which is now commonly seen growing from walls. It was brought to Britain from China at the end of the 19th century and is now frequently naturalised on rubble and walls where the roots can take a firm hold by enlarging cracks in the wall.

Escaping over the wall

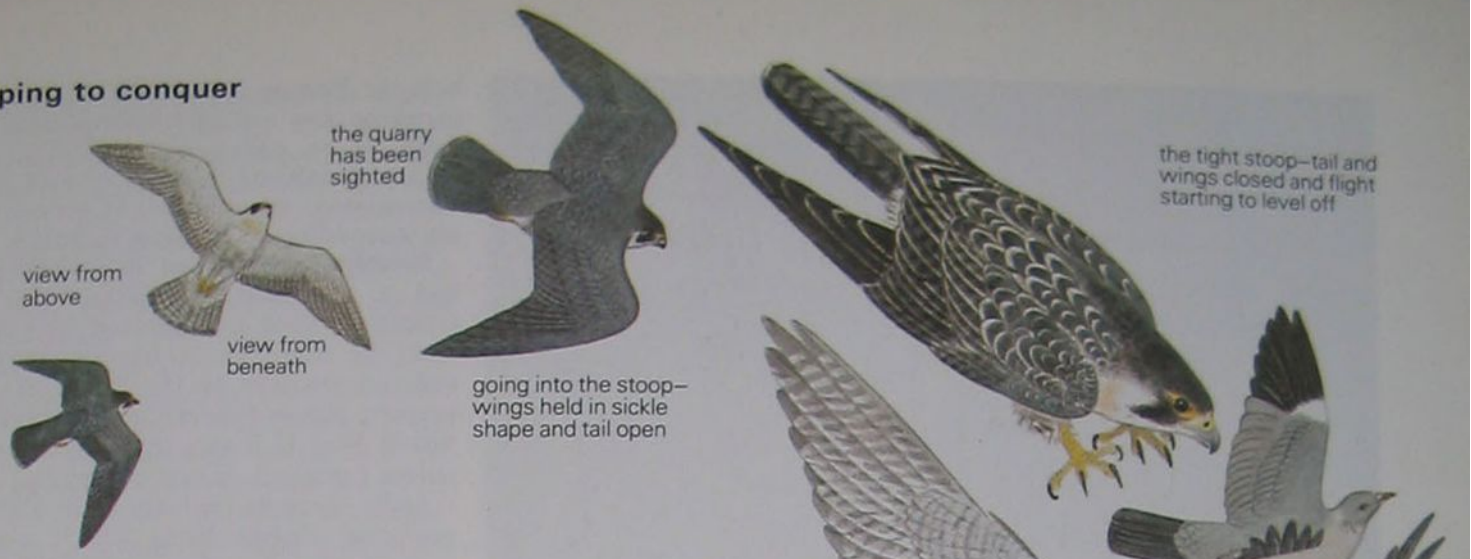
The Oxford ragwort (*Senecio squalidus*) is a native of Sicily, where it grows on poor volcanic soils on the slopes of Mount Etna. Introduced into the Oxford Botanic Garden late in the 18th century, it escaped literally over the wall and was soon growing on the walls around the Garden. In the mid-19th century, with the opening of railways around Oxford, the Oxford ragwort spread rapidly along the embankments and track sides. The wind-borne seeds with their parachute of hairs were probably carried in the turbulent air behind trains. In flower from May to December, each plant can produce as many as 10,000 seeds, enabling it to spread rapidly. Although it is relatively rare in northern Britain, it is on the increase.

THE PEREGRINE: PRINCE OF BIRDS

Among all the birds there is none to rival the peregrine falcon in its powers of flight and its devastating speed. Even when perched in upright stance on cliff top or mountain ledge, it seems to embody the essence of nobility and freedom.



Stooping to conquer


the quarry has been sighted
view from above
view from beneath
going into the stoop–wings held in sickle shape and tail open
the tight stoop–tail and wings closed and flight starting to level off
the catch and lift-off–the quarry is killed with a blow from the hind toe

Everything about the peregrine falcon conveys strength and power. It has powerful shoulders, a short neck, broad chest, large eyes, immensely strong legs and disproportionately large feet armed with formidable talons. The dark eyes, framed in a bright yellow orbital ring, are of enormous size, occupying a large part of the skull, and give the peregrine visual acuity at least four times as sharp as that of humans. The slate grey upperparts of the adults, and the bold black moustachial stripe, contrast with the pale, finely barred underparts.

It is on the wing, however, that the full majesty and speed of the peregrine has to be seen to be fully appreciated. In silhouette from below, as you would normally see it, it is sickle-shaped and heavily built, with a short tail and neck. In level flight it has the rapid wing-beat shared by other falcons such as kestrels and merlins, but it also soars and glides high above the hillsides and sea cliffs where it lives.

In its famous 'stooping' dive, in which the peregrine attacks its quarry (principally other birds), it has been estimated that the bird may reach speeds of between 150 and 200mph, depending on the angle of descent. In level flight the peregrine can attain 60mph or more, with short bursts of speed up to 80mph. But whatever the hunting method it employs–whether it is the stoop or a strike upwards from below–the passing silhouette of the predatory peregrine casts a feared shadow on the ground. It can induce panic in flocks of wildfowl or waders, occasionally putting them into the air to fly at great heights, sometimes for hours on end, and on the ground, nesting grouse, plover and lapwing crouch motionless as the lethal sickle shadow passes over.

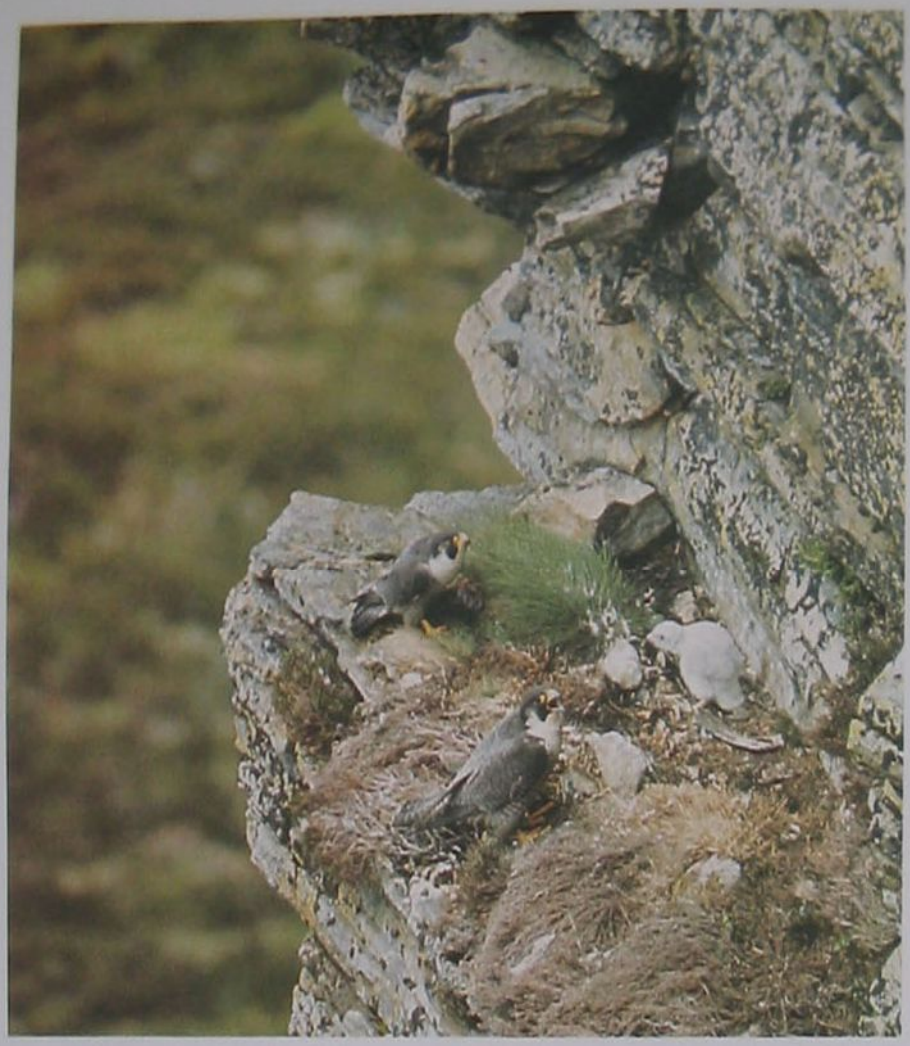
Decline and rise The story of the peregrine falcon has not been one of unrestricted success, especially in recent decades for, in the 1960s, it became clear that there was something seriously amiss with the British population.

Ironically, the first signs of this were picked up when a national survey of peregrines was carried out in 1961, following a petition to the

Above: The peregrine feeds almost exclusively on other birds up to the size of a grouse or pigeon, catching them on the wing by sheer force and speed. The most dramatic technique is the stoop, in which the peregrine, having gained height above the quarry, closes its wings and accelerates at breathtaking speed in a stooping dive of several hundred feet or more to hit the unfortunate prey with its talons in a bone-shaking flurry of feathers.

Peregrine falcon (*Falco peregrinus*); resident bird of prey haunting cliffs and mountains. Male 38cm (15in), female 46cm (18in).

Below: An immature female peregrine; it lacks the adults' black 'moustache' and slate grey underparts.



Home Office by pigeon fanciers who claimed that increasing peregrine numbers were making serious inroads into their homing pigeon stocks. The evidence from the 1961 survey showed clearly that there was in fact a serious reduction in pairs and that, in southern Britain, but less so in the north, peregrines were in headlong decline. By 1962 the number of breeding territories occupied was a mere 56% of the total at the beginning of World War II.

As investigations continued, attention focussed on the presence of several synthetic agricultural chemicals being used in seed dressings, principally DDT and the related dieldrin group of pesticides. Not only were these chemicals responsible for killing many song birds, their persistent nature was also affecting predatory birds higher up the food chain. Other birds of prey–sparrowhawks, barn owls, kestrels–were also affected, but it was the peregrine decline that warned of the grave consequences of the extensive use of these chemicals. Government action led to a reduction in the use of the most damaging poisons and slowly the population, by now reduced to a shadow of its former levels, levelled off and then began a slow upturn.

Through the 1970s this increase speeded up and the remarkable resilience of the peregrine has been demonstrated by its recent recovery in Britain to near pre-war numbers. Over wide areas of its northern range, however, both in Europe and North America, the peregrine has virtually disappeared. It is listed as an endangered species and the British population assumes an ever greater international importance. At present there are some 650 pairs breeding in Britain.

Above: A peregrine family at their cliff-ledge nest. The female is on the left, the male on the right, while the chick, which has not yet lost its grey downy covering, is furthest from the edge. Occasionally peregrines choose to nest in strange places. Some have recently prospected the Post Office Tower in Swansea, but failed to find a suitable ledge.

Below: A peregrine is not such a lordly sight when it is moulting. Notice the extremely powerful talons.

Relationship with man The peregrine has had a chequered relationship with man. Greatly coveted and admired by falconers over the centuries, it has simultaneously suffered attrition at the hands of game-keepers, pigeon fanciers and others. During World War II it was legally controlled to reduce predation on carrier pigeons.

Sadly, since its recovery in the 1970s, the peregrine, despite being strictly protected under the law by special penalties, has been subject to gross predation by both egg collectors and falconers. The RSPB and the police have made strenuous efforts to combat the robberies with protection schemes and a string of prosecutions, but the robberies continue.

Cliff and mountain dweller Essentially the peregrine is a bird of open country. By the nature of its hunting methods it is ill-equipped to deal with birds that can take refuge in the cover of woodland or elsewhere, and it needs to fly down its prey where there is the least chance of losing it once the hunt is under way. Much of Britain is therefore suitable country for the peregrine, but the bird's distribution is restricted for much of the year by the need to find nesting ledges on steep rock faces–it is almost exclusively a cliff-nesting species in Britain. Its breeding strongholds are the mountains and cliff-bound coasts of Scotland, Wales, Ireland and the south-west peninsula of England. Here there are nest sites in abundance and an endless supply of smaller birds as prey.

Nowhere is the peregrine more at home than in the mountains and cliffs of the west and north of our islands. Both inland and on the coasts, pigeons, especially stray homing birds, are the favoured prey, but the range of species taken is very much wider, including birds as large as the shelduck and mallard and as small as house martins and finches.

Many individuals stay in the vicinity of

their breeding cliffs throughout the winter, certainly for as long as the flow of food remains, but others, perhaps predominantly young birds, wander further afield and turn up in river valleys and coastal marshes well away from the breeding area. Here they take a daily toll of the flocks of wildfowl and waders and can often be found using regular perches on flood-drifted logs or fence posts.

Pairs and breeding As in most birds of prey, the female peregrine is markedly larger than the male – as much as 15% in some cases. This sexual size difference means that the female, measurably the more powerful of the pair, is better adapted for taking the largest food items, although the male (called the tiercel) is quicker and more agile.

Peregrines normally pair for life and they and their descendants use the same nest ledge (or a series of alternative sites) with great fidelity generation after generation. Some sites have been used for many hundreds of years and a remarkable fact was that, after birds began to return to the areas from which they had been wholly eliminated in the 1960s, the re-establishing pairs began to occupy the same ledges that their forebears had always used.

Above: A peregrine in flight – the essence of aerial power and majesty, and awe-inspiring to watch.

Below: A female peregrine feeding her chick. A brood of three or four chicks is usual for peregrines.

Once winter is on the retreat, by late February, occupation of the breeding cliff becomes more regular and the pairs increasingly hunt together in the early morning to satisfy their daily food needs. Successful hunting is often followed by spectacular display flights by the tiercel, careering, speeding, twisting and plummeting over and in front of the breeding cliffs. Mutual chasing often takes place and can be breath-taking in its speed and agility. As in many other bird species, the male feeds the female at this period as part of the process of strengthening the bond between the pair.

Mating takes place three weeks before the laying of eggs, and the first eggs appear in the south of Britain before the end of March. Incubation, predominantly carried out by the female, especially in the early stages, begins around the time when the third egg is laid. A full clutch is usually three or four eggs, occasionally five. They are normally laid at intervals of two days, and are mottled and spotted in different shades of reddish brown.

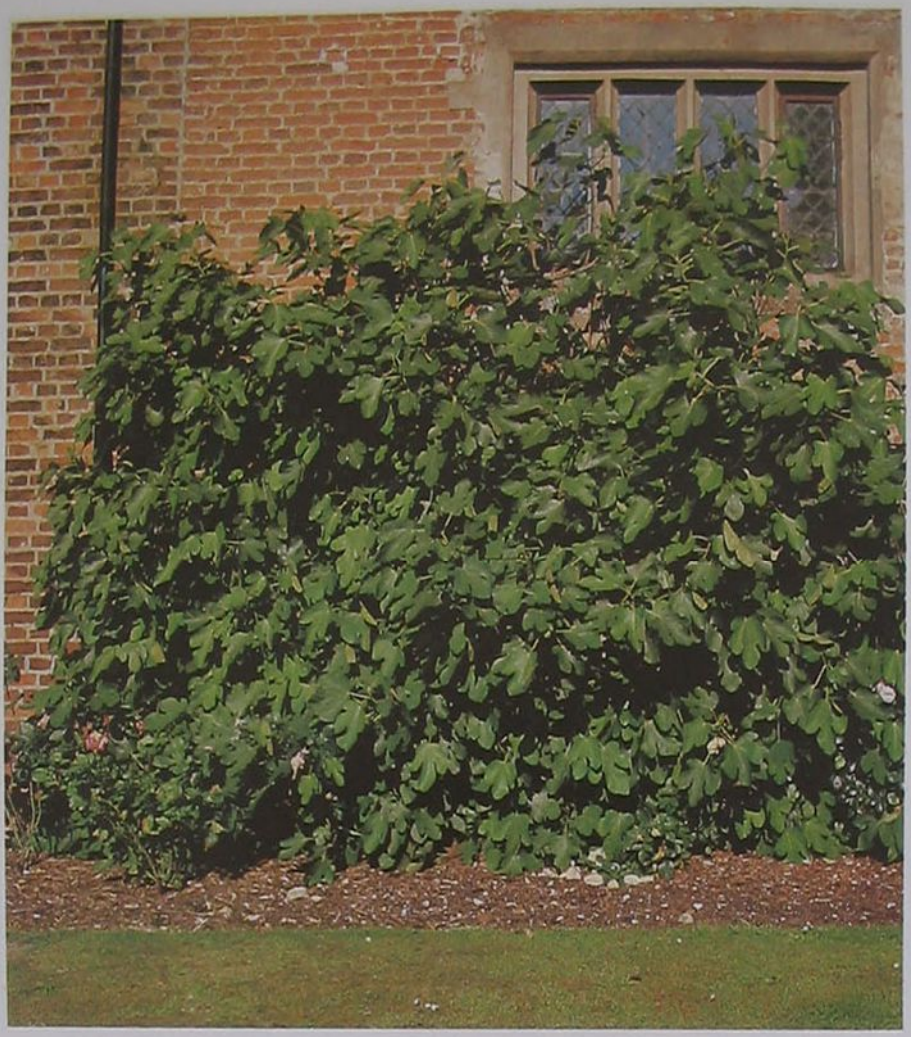
Incubation takes about 30 days and the newly hatched young are tended with great attention by the female peregrine. During the 40-day fledging period the young birds grow rapidly, passing through a grey downy stage when they appear ungainly and immobile. Over the last two weeks of fledging they develop the brown juvenile plumage. The young males leave the nest first.

The contribution of the female to hunting is small at this time and it is the male who provides for the female and the growing brood on the cliff ledge, although from the third week onwards the increasing demands of the young require the female to hunt.

Prospects The future of the peregrine in Britain at present is bright, and this is one of the few areas of the world where the peregrine population has actually increased over recent years. Nevertheless both here and in the rest of the world, the potential problems of human robbery, persecution and toxic contamination remain.

The sport of Kings

Falconry has been practised for over 4000 years and it is reasonable to guess that trained peregrines would have featured from early times. In Britain the Middle Ages were the golden age of falconry, and in the hierarchy of the sport the peregrine was at the very pinnacle, valued above all other birds for its lordly powers of flight and for the size of prey to which it could be directed. Game birds were its principal quarry. The birds were taken to the field hooded and tethered (right). Falconry still has a minority following today and many falconers have a deep knowledge of peregrines in the wild.



LOBE-LEAVED FIG TREES

Although our climate is usually too cold for the fruits to ripen, fig trees are still popular in British gardens and parks for their attractive, distinctively lobed leaves, and occasionally a naturalised fig tree can be seen growing in the wild.

Above: Though rarely seen growing wild in Britain, fig trees are a common sight in town gardens and parks, particularly in southern Britain. They are most likely to be seen growing against a south-facing wall, where the sunny sheltered conditions increase the chances of the fruits ripening.

Opposite: The stout upswept shoots covered with pale grey bark are a characteristic feature of the fig tree.

There are about 600 species of fig in the world. Most are confined to their native tropical and sub-tropical regions, though a few shrubs are hardy enough to be grown in British gardens and some others are cultivated as house plants – notably the rubber plant (*Ficus elastica*). But only one tree species grows as a tree in this country and that is *Ficus carica*, commonly known as the fig tree.

The fig tree is native to western Asia though it has been cultivated in Mediterranean countries since Biblical times. The ancient Greeks are known to have been fond of the fruit, and the Romans probably tried to introduce the tree to Britain, though there is no evidence that they had any success, for the fig does not easily grow in the open in this country.

It was not until the 16th century that the fig tree definitely became established here in Britain, when a certain Cardinal Pole brought some young fig trees to London from the Continent and planted them in the Archbishop's garden in Lambeth Palace. The trees thrived there for nearly 300 years, eventually growing to a height of 15m (50ft) with a girth of 13m (45ft). Throughout their long life they consistently bore heavy crops of fruits until finally succumbing to a severe frost during the winter of 1814.

However, this success turned out to be the exception. In general, fig trees rarely set fruit here apart from in the south of England, and even then only during a hot summer following a mild winter. In Britain, therefore, fig trees are usually grown for their considerable ornamental qualities, in particular for their large lobed leaves. They are usually seen growing against a south-facing wall, where they benefit from the maximum exposure to the sun's warmth. In the south of England some fig trees are free standing and, very occasionally, some can be found growing wild.

Widespreading crown The fig is generally a sprawling shrub or small tree, rarely growing taller than 8m (25ft). The crown often spreads out over a wide area and the trunk usually leans to one side. The branches are swept strongly upwards, giving the tree one of its characteristic features in winter, along with its light grey, smooth bark.

For much of the year, however, the feature most familiar to people is the leaves. These are large – certainly large enough for Adam and Eve's purpose – growing up to 30cm (12in) long and about 25cm (10in) wide. Each leaf has three or five lobes, cultivated forms being more deeply lobed than wild fig leaves. The margins are cut into short, blunt teeth

and the underside of the leaf is marked with conspicuous white veins. Both leaf surfaces feel rough because they are covered with short bristly hairs.

The leaves are borne on thick stalks about 5-10cm (2-4in) long, which in turn are attached to stout, dark green shoots; these are encircled at intervals by bands and bear clearly visible leaf scars.

Flowering and fertilisation The flowering of figs is a fascinating story of just how inseparable a plant and its pollinating insect can become. Figs have no obvious flowers because pollination takes place inside a fleshy receptacle that is destined to become the fruit. The flowers are formed inside this green pear-shaped structure and they can only be fertilised by a particular species of gall wasp of the genus *Blastophaga*. Conversely, the female wasp relies on the receptacles to provide sites for her to lay her eggs. Therefore, the two species rely on each other for their survival–an example of a symbiotic relationship between two organisms.

Once fertilised, the receptacles develop into the familiar juicy fig, a process that takes two years to complete. The susceptibility of the maturing fruits to a harsh winter is one reason why they rarely ripen in Britain. The inside of a fig consists of a thick layer of flesh surrounding a mass of tiny single-seeded capsules, which are the actual fruits.

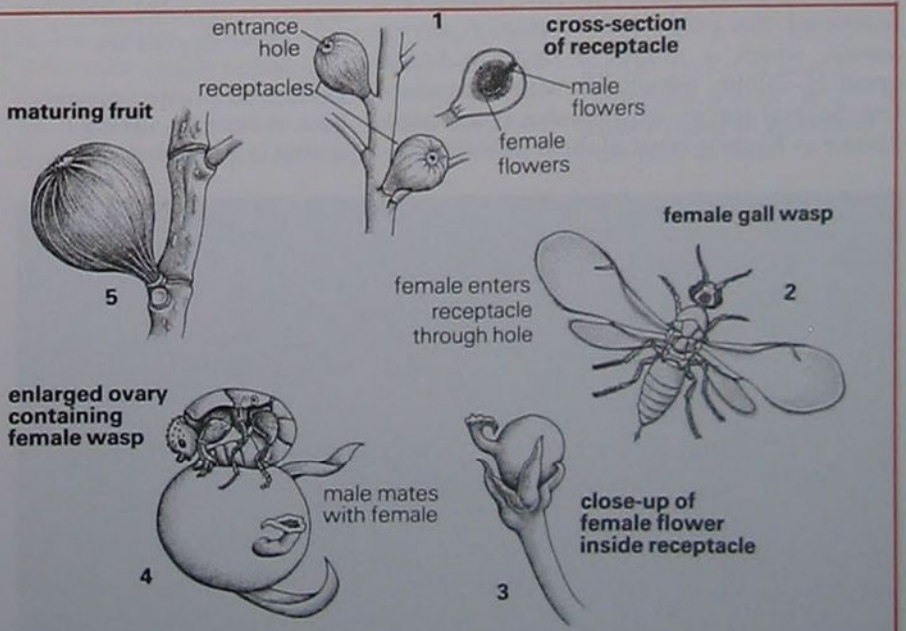
Myths and legends Having been cultivated for so long around the Mediterranean area, fig trees have become the source of a number of myths and legends. In the Bible, fig trees are mentioned many times, the most famous occasion being in the Book of Genesis where, in the Garden of Eden, Adam and Eve used a fig leaf to cover themselves. It is also thought by some authorities that the Tree of Knowledge of Good and Evil, whose fruit was forbidden to Adam and Eve, was the fig tree. In many other cultures, the fig tree is regarded as the Tree of Knowledge and, in Buddhism, legend has it that the Buddha attained enlightenment while sitting beneath a fig tree in India.

Above: The fruits of a fig tree take two years to mature. In the first year they are fertilised and start to swell. By winter they are 1-2cm ($\frac{1}{2}$-1in) long, pear-shaped and green. In the second year they continue to grow and ripen, becoming 5-6cm (2-3in) long and purple-brown. The large green fruit in the picture is in its second year, and the smaller fruits in front are in their first, being borne on the green shoots of this year's growth.

Fig (*Ficus carica*). Introduced deciduous tree, native to western Asia. Commonly cultivated in Britain but rare in the wild. Height to 8m (25ft).

Life-cycle of the fig gall wasp

The flowers of the fig form inside fleshy receptacles, the male being sited close to the entrance hole and the females further inside (**1**). A young female wasp (**2**), dusted with pollen after emerging from a previous fig, crawls inside the receptacle, where she fertilises the fertile female flowers with her pollen and lays eggs inside the ovaries of the sterile ones (**3**). At the same time she injects the sterile ovaries with a growth stimulant that causes them to swell into galls as the eggs develop. The young male wasps emerge first, crawl to the ovaries bearing the females, mate with them and die (**4**). The females then leave the fig, in the process brushing against the male flowers and collecting pollen, and fly off in search of another fig to repeat the cycle. Meanwhile, the original receptacle develops into a mature fig (**5**).



ACROBATIC BEETLES

Click beetles, named from the adults' unique method of jumping, are probably more familiar in their larval form – the agricultural pests known as wireworms.

Above: A pair of click beetles (*Agriotes* species). The larger beetle, lying on its back, is preparing to make its clicking, somersaulting leap.

Below: A click beetle larva is known as a wireworm because it has a very tough outer casing which is resistant to crushing. It is tubular in shape with a smooth, glossy body which enables it to push its way through the soil. The legs are very short and of little use in walking, although they are furnished with claws which enable the wireworm to grip vegetable roots and excavate soil. Not all the species are agricultural pests – *Denticollis linearis*, shown here, is found in rotting timber in woodland.

Click beetles, sometimes known as skipjacks, are members of a beetle family – the Elateridae. The adult click beetle is typically rather flat-bodied and oval in shape, with antennae of variable length. The rather rounded thorax extends backwards at each hind corner, and the outer casing is hard and resistant to crushing.

There are 65 British species, ranging from a few millimetres to about 2cm ($\frac{3}{4}$in) in length, although many of the world's 8000 species are considerably larger. One of the most interesting of these is the spectacular South American *Pyrophorus noctilucus* which, like the fireflies and glow-worms, is luminescent, bearing two light producing areas on its thorax and another at the base of the abdomen. However, none of the British or European click beetles is luminous.

Only four species are generally regarded as serious pests in their larval form. These are three species of *Agriotes* (*A. lineatus*, *A. obscura* and *A. sputator*), none of which is more than about 10mm ($\frac{2}{5}$in) long in the adult stage, and *Athous haemorrhoidalis*, which is a little larger. All are brown or greyish-brown in colour, often with darker heads and yellowish legs. More colourful species include the handsome but rather rare *Ctenicera pectinicornis*, which is usually a uniform bottle green in colour, sometimes with a coppery tint. Several species of *Ampedus*, (previously known as *Elater*) – most of them uncommon – are red and black, while other species of click beetle are yellow, black, dark blue, purplish or bronzy-metallic in colour.

Jumping beetles The partly vegetarian adult beetles are found most commonly among low vegetation or in flowers, where they like to bask in the sun. Their characteristic clicking jump occurs mainly when they are disturbed or threatened by a predator. They drop to the ground and initially feign death by drawing their legs close in to the body, particularly if they have landed on their back. After lying in this position for a few seconds they jump with an audible click, spinning over and over in the air. The leap may be repeated several times if the beetle is unsuccessful in landing the right way up, or if danger still threatens.

The first two parts of the click beetle's thorax – the prothorax and mesothorax – are hinged and freely movable. There is a backward-directed spine on the prothorax which normally rests against a catch on the lip of the mesothorax, just beyond which is a cavity. In order to jump while lying on its back, the click beetle first arches its head and prothorax, so that it is supported by the tip of its head and the ends of the elytra. Then it thrusts its head and thorax rapidly upwards and forwards, forcing the spine over the catch and into the cavity. This brings the 'shoulders' of the elytra into sudden violent contact with the ground surface, propelling the beetle several inches into the air with a clicking sound.

Leaping for defence One theory as to the purpose of these jumps is that they allow the click beetle to right itself when it falls on its back, the shortness of its legs otherwise making this rather difficult. However, since click beetles can and do right themselves without jumping under normal circum-

Left: *Agriotes lineatus*. Length to 10mm ($\frac{2}{5}$in). Common in fields and meadows, May-June. Larva a serious pest.

Right: *Athous haemorrhoidalis*. Length to 13mm ($\frac{1}{2}$in). In woodland, May to June.

Above: *Ctenicera pectinicornis*. Length to 18mm ($\frac{7}{10}$in). In fields near woodland in June, on umbellifers.

Left: *Agrypnus murinus* Length to 17mm ($\frac{7}{10}$in). On open ground, May-July. Below: *Ampedus sanguinolentus*. To 11mm ($\frac{2}{5}$in). On hawthorn blooms, May-June.

stances, the device may have more value in allowing the click beetle to escape from, or deter, predators. Beetles will even leap when in the normal standing position, operating the procedure in reverse. The jump is probably, therefore, used for its startling effect, and also for escape. Even tiny species like *Agriotes acuminatus*, measuring 5mm long, can leap 5-7.5cm (2-3in) into the air, while larger click beetles can manage 30cm (1ft).

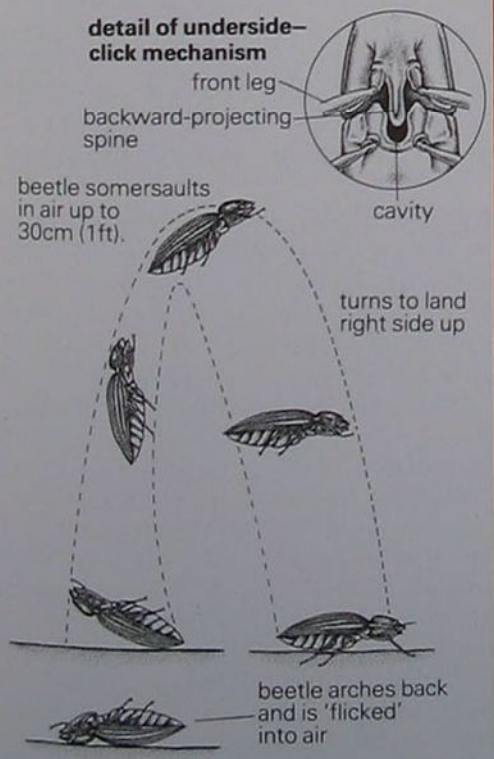
Larval pests Click beetles mate in early summer, laying their eggs singly or in clusters in the soil, usually adjacent to plant roots. Some species, such as the all-black *Melanotus erythropus*, lay their eggs in rotting wood, particularly where it has been partially broken down by fungal activity. After about a month the eggs hatch into larvae known as wireworms. These reach about 2.5cm (1in) in length and are usually yellow or reddish-brown with a darker head. They have short antennae and jaws that are equipped with powerful, biting mandibles.

Wireworms can cause extensive damage to fields of root vegetables or crop seedlings. The problem is often more severe in fields which have been formed from ploughed-up grassland, probably their natural habitat, since the larvae turn their attentions from grass roots to whatever crop is planted. When as many as 600,000 to a million wireworms per acre are found, then treatment of the land with pesticides is necessary.

Many species of wireworm are at least partly carnivorous and some may be wholly so. The larvae of *Agrypnus murinus* and *Stenagostus villosus*, for example, feed on the larvae of wood-boring beetles, notably longhorns.

In common with many other beetle families, the larval development of click beetles can be lengthy, varying from two to six years. The larvae are most active in the spring and early summer, and they stop feeding to hibernate in the winter. Pupation usually takes place within an earthen cell, in rotting wood, or beneath bark. The adults usually emerge towards the end of the year, when they too overwinter; they live for about a year.

Acrobatic leaper


detail of underside–click mechanism
front leg
backward-projecting spine
cavity
beetle somersaults in air up to 30cm (1ft).
turns to land right side up
beetle arches back and is 'flicked' into air

A click beetle jumps by arching its back and thrusting a spine on the hind edge of its first thoracic segment violently into a cavity in the next segment. This makes the 'shoulders' of the elytra strike the ground, throwing the beetle into the air.

Agricultural pests

Wireworms attack a wide variety of plants, including such root crops as turnips, beets, onions and potatoes. Seeds and young seedlings are also eaten, the wireworms chewing the area just above the seed and rootlets and causing the plant to wilt. Although pesticides are the usual method of controlling wireworm numbers, other effective measures are ploughing in early spring, allowing the field to lie fallow or planting crops less susceptible to attack, including barley, rye and leguminous species. Double ploughing also turns up the wireworms which are then eaten in large numbers by insectivorous birds and mammals such as rooks, moles and shrews.

Below: This click beetle–*Denticollis linearis*–is usually found in woodland from May to July.

WISTMAN'S WOOD

Wistman's Wood in Dartmoor, one of our few surviving fragments of broad-leaved forest, has been struggling for many centuries to exist in extremes of wind, wet and cold.

Above: Wistman's Wood in winter—an air of mystery seems to hang over the ancient, twisted, tangled oaks rooted deep between the rocks. The Wood does not harbour many birds, but the wren (below) is one that seems to be at home there.

Dartmoor in south Devon is the mother of many little rivers which radiate in all directions across a world of bogs and treeless moorland. The West Dart, like the rest a lively torrent that comes splashing, sometimes roaring, down its rocky bed on the south side of the moor, has on its left bank, at about 430m (1400ft) above sea level and just over a mile from the hamlet of Two Bridges, a remarkable grove of trees—Wistman's Wood.

This wood is one of Britain's few fragments of broad-leaved forest surviving up near the natural tree limit for this part of the country. The Lake District has a few such forests, and on Dartmoor there are two others besides Wistman's Wood. As well as coping with an unkind climate—cold, wet and windy—these woodlands have to survive on difficult ground. At Wistman's Wood the trees—mainly oaks—grow out of a steeply tilted strip of block scree that lies along the slope parallel with the river. Above stretch miles of heathy moorland topped by the rocky outcrops called tors. Between wood and river is a boggy terrain tussocky with purple moor-grass. All the soils in and around the Wood are acid (with a pH averaging five). The Wood became a nature reserve in 1961. Inacessible by car, it is reached by a public footpath that goes up the valley from Two Bridges.

Odd oaks Wistman's Wood has stimulated an interest out of all proportion to its size. It has been written about for several centuries by topographers, historians and folklorists; and in recent years it has been much studied by ecologists who have discussed its possible origins, the reasons for its survival and the changes known to have occurred.

The most obvious feature, as you near the Wood, is how closely restricted the trees are to the area of scree. This suggests that the Wood has survived there, but not on the surrounding moor, because the seedling trees are able to become established in the deep crevices before they have to put their heads above boulder level to face the weather and the grazing of sheep, cattle and ponies.

An intriguing puzzle about the Wood concerns the species of oaks there. In highland Britain the characteristic oak is the sessile oak (*Quercus petraea*), with acorns that sit stalkless on the twigs. This is in fact the oak that appears almost everywhere on Dartmoor. Yet at Wistman's Wood the oaks are the pedunculate species (*Quercus robur*), bearing acorns equipped with stalks. What is this typical lowland oak doing high up in the

very heart of sessile oak country? Unfortunately, there is no simple answer to this question. Not enough is known about the factors affecting the present distribution of sessile and pedunculate oaks to explain such an anomaly.

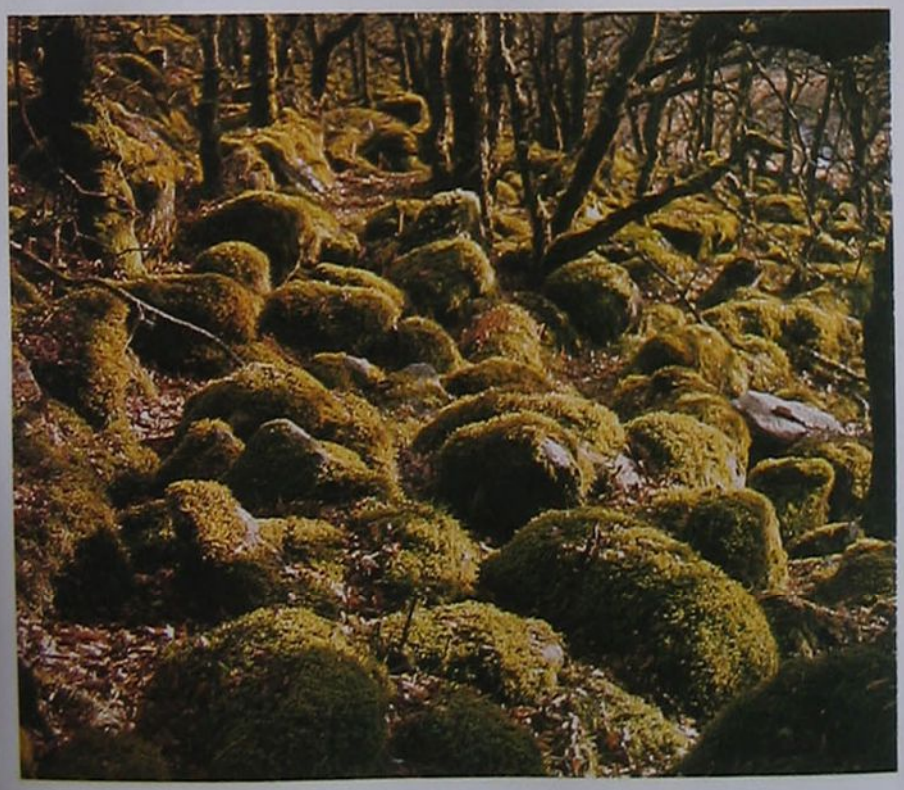
If the prehistory of Dartmoor's woodland is uncertain, so too is its history. Pastoralists in early times, and tin miners in later centuries, have been the chief agents of tree destruction. The question is: why did they spare Wistman's and the other little woods? Was it simply that they never found it worth the trouble to clear woodland off such difficult terrain as block scree? Or was it in fact cleared, but managed to make a comeback in the shelter of the boulders–a comeback that would have been impossible in open moorland?

Within the Wood Wistman's Wood has been in existence for several centuries at least, for some of its trees are known to be that old. Rooted deep between the rocks, few of these ancient oaks rise more than three times the height of a man. They are very thick in the trunk, leaning, battered, bent, holed, cracked and shattered, their weirdness increased by branches bearded with long grey-green lichens and upholstered with mosses, polypody ferns, great woodrush and even bilberry bushes. It is a rain-forest type of vegetation only possible in a wood that in winter is sometimes in the cloud zone for weeks on end and even in summer retains its damp coolness.

Below the trees the ground and many of the rocks are so well covered with mosses, liverworts, ferns, brambles, woodrush and wavy hair-grass that there is little room for anything else. But here and there you can find small clumps of heath bedstraw, tormentil, wood-sorrel, sheep's sorrel and climbing corydalis. At any season the birds are few. The most usual are chaffinches, blue tits, coal tits, woodpigeons and carrion crows. Wrens, the troglodytes of the bird world, seem to rejoice in all the rocks and fissures, and ravens and buzzards fly over daily, but there is little to draw them into the wood unless a sheep dies there. The droppings of foxes are frequently to be seen, suggesting a population of rodents. Otherwise signs of mammals are sparse. The official guide to the reserve reports that adders are common.

Above: A distant view of Wistman's Wood, lying to one side of the West Dart River. What is so surprising is the small size of this wood–it covers about 3 hectares (7½ acres) and few of the trees rise to more than three times the height of a man.

Below: The rocks and boulders littering the ground under the oaks of Wistman's Wood are so covered in mosses that there is little room for anything else to grow.



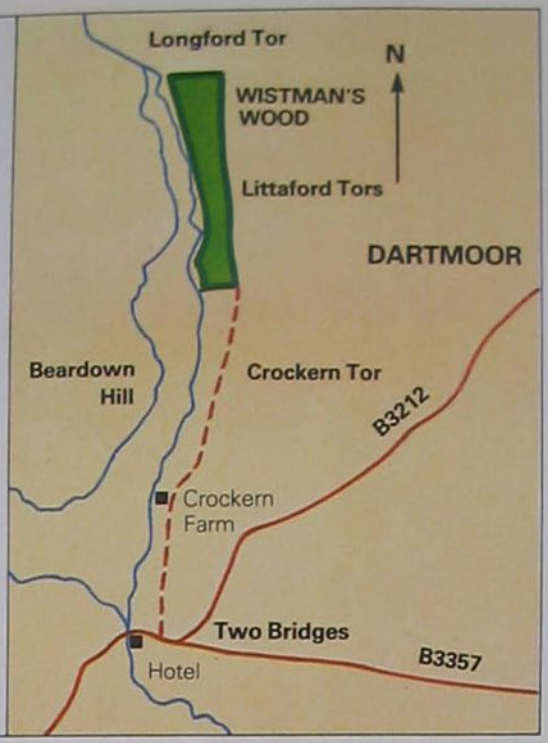
Then and now Though Wistman's Wood may seem a strange sort of wood today, the evidence is strong that less than a century ago it was a very much more extraordinary place. For it was then described as a tangle of dwarfed and ancient oaks whose branches sprawled so thickly over the blocks of granite that there was no way through it. Then, too, the carpet of mosses was so deep from end to end of the wood that the gaps between the rocks were all hidden, making scrambling hazardous.

Today the Wood, though still delightful, is certainly not the branch-obstructed jungle it was, and the mosses, though they still make the whole wood green within, no longer sprawl with soft luxuriance over every crevice. When ecologists sought a reason for these changes they realise that the Wood as a whole is now taller than it was a century ago and that the leaf canopy no longer lies close above the mossy rocks like a blanket. Wistman's Wood has become a little more like a normal, open, airy wood and no longer provides the extreme humidity its wealth of mosses so enjoyed in the past.

Wistman's trees are not only taller these days–they have also won new ground, as became apparent when recent photographs

Wistman's Wood

This wood, sited within the Dartmoor National Park boundary, is owned by the Duchy of Cornwall and became a nature reserve in 1961. The climate here is harsh, with a very high rainfall of about 215cm (84in) a year. The Wood is reached from Two Bridges via a public footpath as far as Crokern Farm, from there being marked by orange spots on the boulders. There is no restriction of access but a permit is necessary for collecting specimens of flora or fauna.



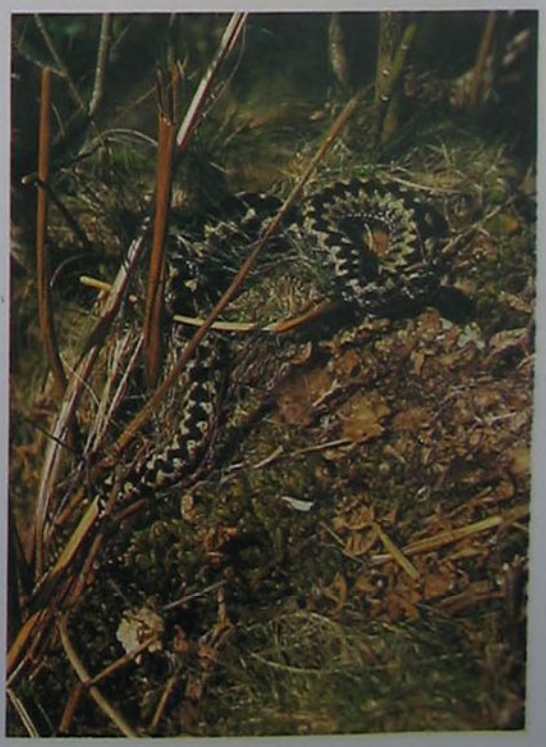
were compared with those taken half a century ago. Until then it had generally been assumed that the wood was shrinking in area, an idea strongly suggested by its fragmented appearance (it is divided into three irregular blocks with wide spaces between). Yet the photographs now show quite clearly that the wood has colonized new areas of scree. This spread is tentatively attributed to better growing conditions. Ecologists point to the period 1880-1950 as being, on average, one of unusual mildness, when seedling oaks may have grown with a vigour they had not been capable of for a very long time. So, for a few decades, they were able to triumph in the unending struggle against animals. Perhaps if we could reconstruct the whole history of Wistman's trees and mosses, we would find that they have always been especially sensitive to climatic change because they are surviving at the very limit of their endurance; and that for many thousands of years the wood has been waxing or waning regardless of any human interference.

The experimental section In an attempt to shed more light on the effects of grazing and non-grazing, an experimental section of the Wood was fenced off against stock in 1965. Today you can see that the ground flora within the fence has responded by transforming itself into a tall, dense wilderness proper to natural woodland. At the same time, many oak saplings, formerly suppressed by animals, have grown well, especially at the edge of the wood where the light is good.

Though Wistman's Wood is a reserve, it is not guarded permanently by a warden. Because it is so accessible it is open to unintentional damage by children playing games and scrambling over rocks and trees, dislodging the vulnerable mosses and wild flowers. There is also the serious threat of trampling and collecting by parties of students. So is there a case for fencing in much more of the wood than is already protected within the present experimental plot? Or are fences too dreadful an intrusion into the wilderness of the moorland as it is at present?

What's in a name? People have often wondered about the origin of the strange name 'Wistman's'. Could it have come down to us all the way from the time when a Celtic language was spoken on Dartmoor? If so, it could be a distortion of two ancient words *wisg* (water) and *maen* (stone)–suggesting some meaning such as 'the stony wood by the river'. Or a possible English foundation for the name is 'Wealasman's Wood', *wealas* being a word the early English used for 'foreigners' and which could well have been applied to the Celtic inhabitants of Dark Ages Dartmoor by the English. 'Wealasman's Wood' may then have been turned into 'Welshman's Wood', for this was one of the names of the Wood until the end of the last century.

Above: A feature of Wistman's Wood is the luxuriant growth of mosses along the oak branches, these mosses in turn supporting an exotic 'foliage' of epiphytes such as the polypody ferns shown here. Lichens, great wood-rush and even bilberry also grow on the trees–the result of a rain-forest type of climate that in winter shrouds the wood in clouds for weeks on end, and even in summer ensures that the atmosphere remains cool and damp.



Right: If birds are few in the Wood, other animals are even scarcer. One creature you may come across is the adder–don't disturb it and it will do you no harm.

THE WORLD'S MOST BEAUTIFUL PONIES

The Welsh mountain pony is widely regarded as the most beautiful pony in the world. It has enormous presence, and a stallion, whether silhouetted against the skyline of his native hills, or in a showring, is an especially memorable sight.

Above: A Welsh pony making the most of a patch of grass in the middle of winter.
Native ponies are instinctive weather forecasters, and Welsh hill farmers usually get up to 24 hours warning of bad weather, as the ponies come down to the valley bottoms or into the small dingles where streams are running. During winter they spend much of their time sheltering away from the exposed high ground.

Wales is fortunate in having four breeds of native ponies, each with its own characteristics but which, in some respects, may appear rather confusing to the unitiated.

The smallest–and the breed from which the other three have developed over the centuries–is the Welsh mountain pony. This lovely little pony stands up to 12 hands in height. It is registered in Section A of the Welsh Stud Book, and is frequently referred to simply as 'Section A'.

Next in size is the Welsh pony, described as being a larger version of the Welsh mountain pony, which stands up to 13.2 hands. It is registered in Section B of the Stud Book. Section C is devoted to the Welsh pony of the Cob Type, also standing to 13.2 hands.

The largest of the Welsh breeds is the Welsh cob, or Section D, which stands over 13.2 hands, and is a larger edition of the Section C. The Welsh cob is of special interest, as it is the only breed of British mountain and moorland pony that may stand over the maximum pony size of 14.2 hands–there are even cobs of nearly 16 hands.

The Welsh mountain pony At best this pony possesses an attractive, small, typically pony-shaped head, tapering to wide, flaring nostrils, and with a distinctively 'dished' (slightly concave) profile. The ears are small, and the eyes large, set well apart, bold and expressive. Blue eyes are still found in some ponies, and are indicative of descent from some of the oldest breeding lines. The mane, which crowns an elegantly arched neck, is profuse and flowing, and the well-set tail is long, full and carried gaily. The action of the ponies is distinctive (see box). It is interesting to note that when the ponies are bred away from their native environment, they tend to have a flatter foreleg action, which is not considered correct.

The Welsh pony This pony, or Section B, is very similar to the Section A, but is larger, and more suitable as a riding pony. This means that it shows possibly slightly less knee action and a little more refinement than its smaller relative, but it should still possess the good bone (the circumference of the foreleg below the knee) and the sturdiness of the true native pony.

There are still a small number of Section B ponies on the Welsh hills, but in common with the other Welsh breeds, far more are now bred on private studs all over Britain and in many countries of the world.

Section C and **Section D** Both of these cobs, although developed from the Welsh mountain ponies, have hardly changed since medieval times. It is unlikely that the Section Ds ever lived wild on the hills. Any pony that is in excess of about 13.2 hands at the most is too large to be able to eke out a living under the rigorous conditions prevailing.

The cobs have been developed as riding and harness animals, especially for farm work, and in comparatively recent times they have been subjected to infusions of Hackney blood, from which it is believed that much of their spectacular high knee action comes. This action is generally regarded as being typical of harness animals, but as well as going well in harness the cobs of both Sections have been renowed as riding ponies for many centuries. Their best pace is the trot, and the 'trotting out' of Welsh cobs by their handlers, who hold them on a single long rein, is often the highlight of show classes. In the past, animals were assessed for breeding almost entirely on the results of trotting races.

The cobs are of much heavier build than the Section A or B, and the Section D cob is also taller. In spite of this, both cobs should

Right: Mutual grooming between a mare and her foal. If they are parted the foal instinctively returns to where it last saw its mother and waits for her to return.

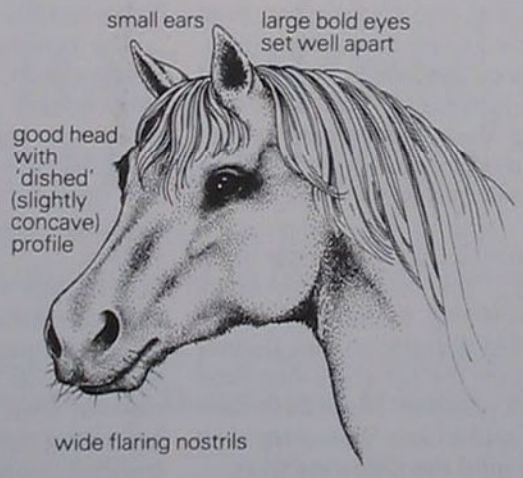
WELSH PONIES AND COBS
Size Welsh mountain pony (Section A) Maximum height 12 hands (122cm/48in); Welsh pony (Section B) and Welsh pony of cob type (Section C), both maximum height of 13 hands 2 inches (137cm/54in); Welsh cob (Section D) over 13 hands 2 inches.
Colour Bay, brown, black, palomino (gold), grey. Never piebald and skewbald.
Breeding season May until August.
Gestation Approximately 11 months.
No of young Normally one. If twins born, one often dies.
Life span 20-30 years.
Food Coarse grasses, rushes, reeds, gorse, heather, ling, some bog mosses.
Distribution Black Mountains, Brecon Beacons, Prescelly Mountains, the Long Mynd and some of the hills of North Wales.
Breed Society Welsh Pony and Cob Society.
Where to see Welsh ponies and cobs The Royal Welsh Show, Lampeter Stallion show, Ponies of Britain shows, Northleach Show.

Left: A mare with her filly. Welsh ponies are famed for their intelligence, temperament and superb jumping ability.

Right: The head of a Section A, showing the 'dished' profile.

retain their native pony characteristics of small heads with neat, small ears, and with proportions such that the depth of the body, measured just behind the front legs, is the same as the length of the legs.

Ponies of the mountains The ponies that remain on the Welsh mountains (many fewer now), be they Section A or Section B, live the hard, rugged life that has been the lot of their breeds since prehistoric times. Their food varies according to the time of the year. During spring and summer the ponies are more often found near the tops of the hills where they eat the grasses that are then at their best. In early spring, a few ponies that have fared badly during winter, may venture into the mountain bogs in search of the new season's grass. Unfortunately, some are too weak to struggle out again, and each year a few are lost in this way.



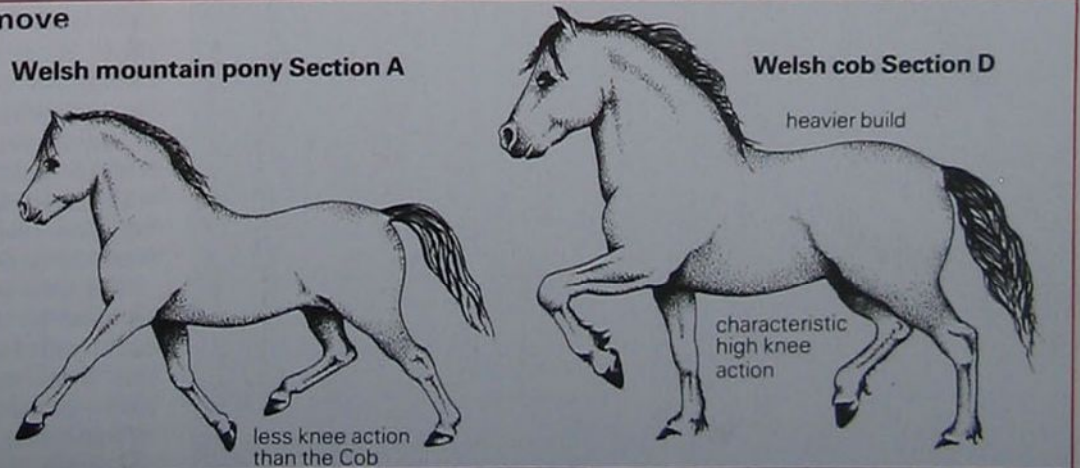
During the foaling season (from about May to late July) mares and foals may come down from the highest ground to where the bracken grows, perhaps to gain some respite from biting flies or from the heat, or to eat some of the grasses that grow in and near the bracken. Bracken itself, if eaten in anything but small quantities, can cause illness and some foals die from bracken poisoning.

Today's ponies It cannot be said that the majority of ponies on the Welsh mountains live an entirely natural life these days, as their breeding is to a large extent controlled by human intervention. So as to eliminate the possibility of mares foaling early in the year when the weather is still likely to be bad, few, if any, stallions are left out on the mountains all year round. The great majority are not turned out until May 1st, so that, with a gestation period of 11 months, no full-term foal should be born before April at the earliest. Nowadays, many owners also take their mares off the hills during the worst of the winter.

When the stallions are turned out, they gather their own herd of mares around them – usually the same ones as in previous years. Sometimes, a stallion will 'poach' a mare that belongs to another; the robbed stallion will

Welsh ponies on the move

The action of the Welsh mountain pony, as in most native breeds, shows a certain amount of bending of the knees of the forelegs, matched by picking up of the feet of the hind legs. This results in a slightly shorter stride so they can move freely and easily over rough ground. Cobs have a spectacular high knee action; their best pace is the trot.


Welsh mountain pony Section A
less knee action than the Cob
Welsh cob Section D
heavier build
characteristic high knee action

Above: A cob mare and her foal. Cobs are stronger and of much heavier build than either Section A or B ponies, and in the past they have been used for riding and harness animals, especially for farm work.

then go into the poacher's herd and retrieve his property, usually without any marked aggression. In general, only stallions aged five years or over have any success in collecting a herd of mares.

When a mare is ready to give birth, she goes off on her own, and stays away until her foal is strong enough to join the herd. Sometimes, however, the herd stallion will notice that a mare is missing and retrieve her, even if she has only foaled a few hours previously. With ears flat (a threat posture in horses), and mouth wide open, he will gallop her back into the herd, leaving the unfortunate foal to follow if it can. On occasions the pony owner will find such a foal, and carry it back to its mother.

As winter approaches, the hill ponies begin to grow their long, thick winter coats – much earlier than those living in lowland areas. It has been observed that the poorer, thinner animals seem to grow thicker coats than their better-conditioned relatives. Most have their coats through by mid to late September, and do not shed them until the following May.

A striking illustration of the difference in protective qualities of coats grown by the hill ponies and those that have not been exposed to such rigorous conditions was seen in 1955, when a bout of extreme weather came in mid-May. The ponies that had wintered on the hills and still had their coats survived, while the others, which had already shed most of their protection died in the exceptionally harsh conditions.

The ponies are rounded up two or three times a year, by their owners mounted on other ponies, and the foals are taken for sale, or are ear-tagged and allowed to rejoin the herd. In times past, the ponies were so wild and unused to humans that the only way to approach them was to 'stalk' them from behind.

Although fossil remains and ancient records show that the ponies have lived on the hills since pre-historic times, they have been subjected to the influence of other breeds since at least medieval days. Arab stallions have been turned out, and have undoubtedly instilled more quality into the breeds, but whether the typical dished profile (the hallmark of the Arab horse) actually came from them is a matter for discussion. Some authorities consider it a characteristic of various mountain species, and instance breeds of mountain sheep which have the same feature. Small thoroughbreds were also used, which again would have imparted refinement, but, less favourably, would have detracted from the native hardiness.

The two cob breeds have also been influenced by others. The Hackney influence has already been mentioned, and it is assumed that there must have been an infusion of heavy or carthorse blood, giving the great strength and substance for which the cobs are rightly famed.

Below: Welsh ponies in the Brecon Beacons. The ponies used to be extremely shy and ran from humans. However, today, many parts of the Welsh mountains have become National Parks and the ponies are more used to people and have become less suspicious.

BIRDS THAT CROSS THE ATLANTIC

Each year it is the fate of a small number of birds from Canada and the United States to be blown out to sea by an Atlantic storm. Some, diverted from their normal migration and assisted by powerful westerly winds, arrive on the coasts of Britain and Ireland.

Above: A pectoral sandpiper, the commonest American vagrant on our shores. Over the ten years from 1958-67, a total of 243 pectoral sandpipers were recorded in Britain and Ireland, compared with 269 other American waders of 17 species. Particular places have the reputation for harbouring American birds, for instance Ballycotton and Tacumshin in southern Ireland, and the Scilly Isles off Land's End.

Many of the excitements of seeing birds in the wild in Britain can be enjoyed by everyone. But there are occasions when even an apparently nondescript bird proves to be a rich and rewarding discovery for the birdwatcher who is able to identify it as a vagrant that has come across the Atlantic from North America. There are now thousands of records of birds of many species that have made this unintentional journey, ranging from large, powerful seabirds and ducks through many species of waders to the tiny warblers, vireos and sparrows – such as the elegantly patterned white-crowned sparrow.

Lost in the storm Vagrants are birds that have been diverted (usually by the weather) from their normal movements, and consequently arrive unexpectedly in a foreign country, perhaps thousands of miles outside their normal range. Usually only small numbers of birds are involved in this movement, and they are often lone individuals, having lost contact with the rest of their species for ever. The vagrants may be noticed by birdwatchers in the area of their landfall, and then little is known of their fate. It is thought that some start to fly back to America, but with generally prevailing westerly winds across the Atlantic, the attempt is bound to be futile.

Some have been noticed joining a British flock of a related species, such as the Hudsonian godwit that was seen on the Humber recently, among a local flock of godwits. One rare occurrence was the reporting of a pair of spotted sandpipers from North America that actually bred in their new home in Skye, in 1975; but the family did not survive. For American birds, the status of vagrant is likely to be a grim predicament.

The numbers involved It is known that every year well over 100 vagrants arrive from across the Atlantic and are recorded (many more probably arrive, without being seen or recognised). For example, the Rarities Committee of the journal *British Birds* reports that in 1980 there were 189 records (birds or groups of birds) of 28 species which must have come from America. Most of these were of

Above: A Forster's tern, first recorded as a vagrant in Britain in 1980, when just one was seen. It is distinguished from the common tern by its pale outer wing feathers, orange legs and orange beak.

Left: The white-crowned sparrow is quite different from our house and tree sparrows, with its vividly striped head and longer tail. The American sparrows belong to a different family; many of them, like this one, are long-distance migrants to the southern United States, the Caribbean and Central America.

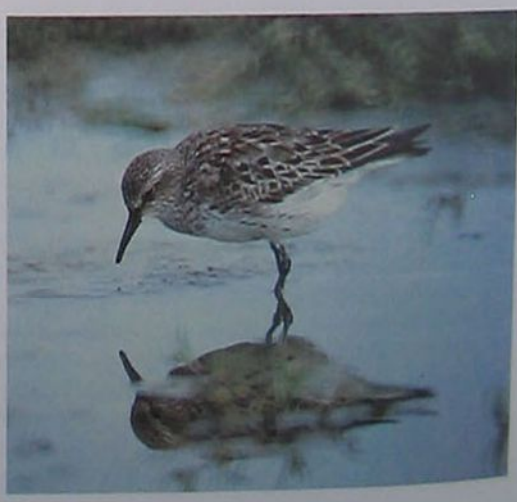
waders (108 records): 11 species were listed without including the pectoral sandpiper, which comes across the Atlantic so often (though still as a vagrant) that it is not rare enough to appear in this list. A further 62 records were of ducks (six species) and 12 were of gulls (four species). The remaining seven birds were individuals: a pied-billed grebe, a Forster's tern (the first ever recorded), a yellow-billed cuckoo, a Swainson's thrush, a red-eyed vireo, an evening grosbeak and a black-and-white warbler.

Past disbelief The birdwatcher of 50 years ago would have greeted this list with suspicion. Far fewer American birds were reported in those days, and the average birdwatcher's resources would not include identification guides enabling any but the most distinctive species to be recognised. When American vagrants were noticed, it was suspected that they had 'hitched a lift' on a ship across the Atlantic rather than having made the journey on their own.

A more accurate understanding of the capabilities of migrating birds has come from detailed research during more recent times. One species studied, the blackpoll warbler, is a tiny bird breeding around Hudson Bay in Canada and migrating first to Massachusetts and the northern coast of New England. From there, it makes an autumn flight to the south-east – out to sea. As it moves southwards it reaches the south-west trade winds, and is carried westwards to make a landfall in the West Indies or South America, some four days of continuous flying after it sets out. It is able to fly for so long because it stores energy, in the form of subcutaneous fat, for the journey.

The distances involved in this flight are comparable with those from America to

Right: In 1981 this American bittern was photographed in a reedbed near Newport, Gwent. The bird spent many weeks in this area before birdwatchers lost track of it. It is slightly smaller than our own bittern, with a distinctive 'moustache' and black neck patch that can be seen in this picture.



Bottom right: A white-rumped sandpiper, among the most frequent of American waders (after the pectoral sandpiper) to appear as a vagrant. On the ground, sandpipers look similar, but in flight they display their characteristic markings. The only other sandpiper with a white rump is the curlew sandpiper, which migrates through Britain from Siberia.

Britain across the Atlantic, and sometimes the eastward movement of a depression across the ocean can catch up migrant birds and whirl them across in as little as two days.

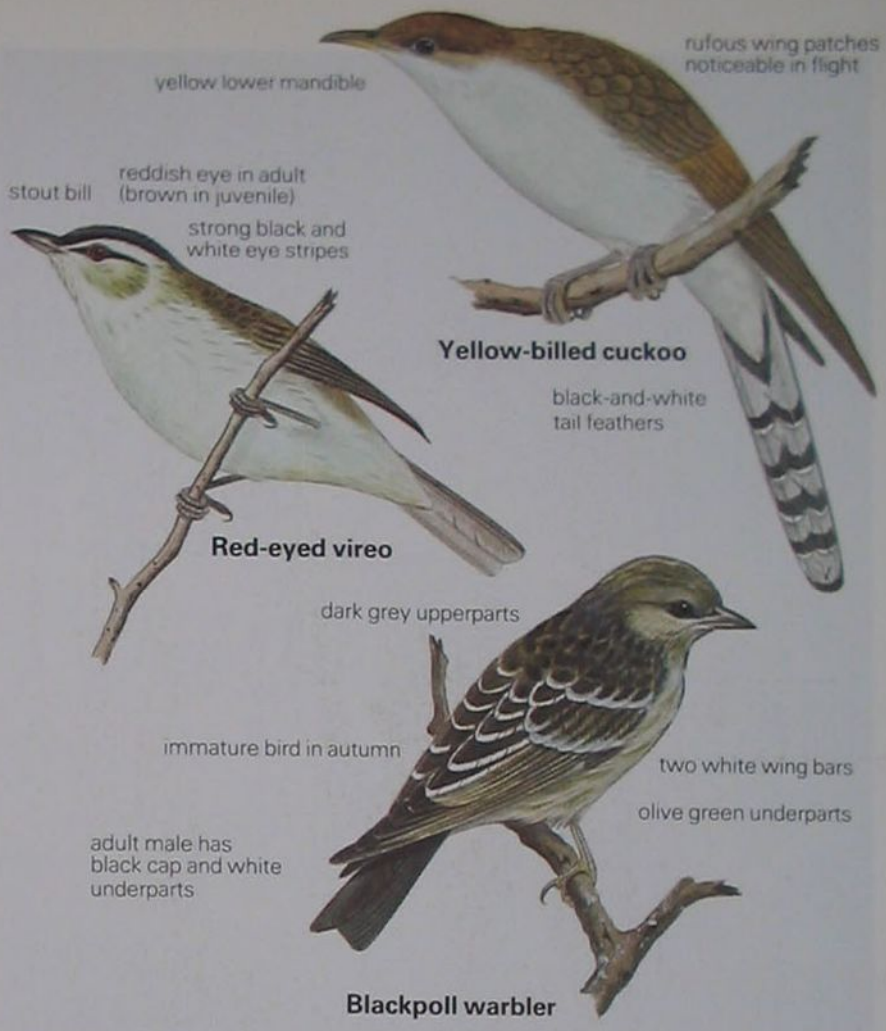
Seabird puzzle Naturally seabirds, which are perfectly capable of landing to rest and feed on the sea, feature prominently on the list of vagrants. There is, however, a very obvious difficulty in telling which are vagrants – many species are exactly the same in North America (at least on the eastern coast) as in Europe. There would certainly be no chance of distinguishing, in the field, between a gannet from the St Lawrence and one reared on Bass Rock in Scotland.

Where there are differences – as for instance in many of the gulls – today's birdwatchers are becoming skilled at identifying the visitors. American species found in Britain and Ireland include the ring-billed gulls, Bonaparte's gull and Franklin's gull.

American waders The most widely seen American birds are the waders. The most common species, the pectoral sandpiper, has been seen in most counties of Britain during the last 25 years. As with all American vagrants, records are commoner towards the south-west of England and Ireland, and towards the Shetland Islands. Almost all are found between August and October.

Some waders are clearly recognizable as American relatives of European species – the greater and lesser yellowlegs, for example, are obviously similar to our redshank and greenshank. Others have no direct counterparts in Europe – for instance the stilt sandpiper and buff-breasted sandpiper. Many of the standard field guides now illustrate a range of American waders that have regularly been recorded.

What's that bird? The more unusual American vagrants seen in recent years include the belted kingfisher, a much larger bird than our own kingfisher; the American kestrel, a rather delicate small falcon; the nighthawk, one of the many American nightjar species; and even a sandhill crane, a huge species of soaring migrant that astonished the birdwatchers on Fair Isle in the spring of 1981.

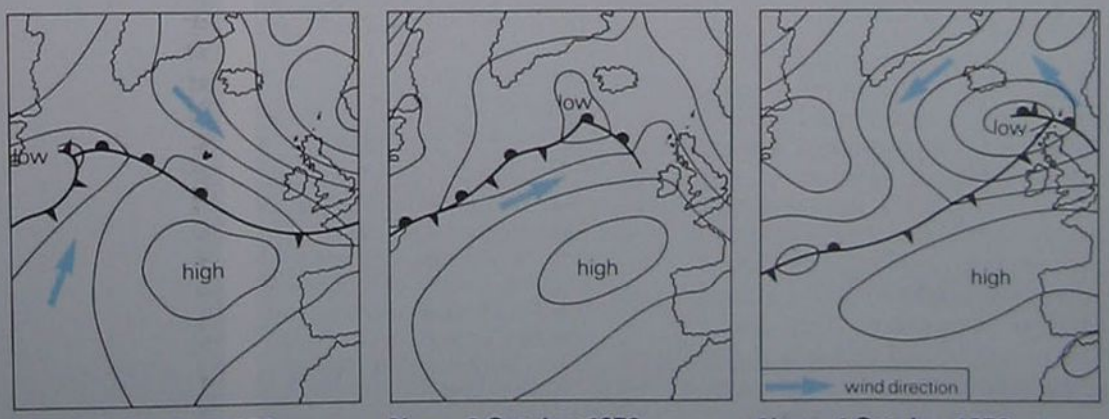


Another category consists of the small birds that migrate (in normal circumstances) by flying at night. Many of these belong to families not naturally occurring in Europe. All the North American warblers, for example, are from a separate family. All the same, these tiny birds, weighing less than 10g ($\frac{1}{3}$oz), behave very like our own warblers. The species recorded in recent years include the black-and-white warbler, Tennessee warbler, myrtle warbler, blackpoll warbler, yellow-rumped warbler, Cape May warbler and the striking American redstart, which is classified as a warbler, unlike the redstart in Britain. Other American families seen in Britain are the tanagers, vireos and sparrows.

Above: The red-eyed vireo (left) is similar to a warbler, but with a heavier bill. The yellow-billed cuckoo (top) is smaller and more elegant than our cuckoo, from which it is best distinguished by its striped tail. The blackpoll warbler (bottom) is one of the more regular American warblers to appear as a vagrant. The adult males live up to the name of blackpoll for they have a black 'cap', and their underparts are white; but virtually all the vagrants are juveniles, as shown.

Flying to Europe

The weather maps show how rapidly a depression can cross the Atlantic. Winds round a depression blow anti-clockwise, so on the south side they become strong westerlies. In September 1970 three unusual vagrants were recorded in Cornwall, including an American thrush known as the veery; all had arrived with these westerlies.



Noon, 2 October 1970 | Noon, 3 October 1970 | Noon, 4 October 1970

CARNIVOROUS BUGS: HUNTING TO KILL

Although the name 'bug' is commonly given to a wide range of insects, it really belongs to insects of the order Hemiptera. These have piercing and sucking mouthparts and include several carnivores and blood-suckers among the many plant feeders.

The true bugs of the Hemiptera – including shield bugs, capsid bugs and aphids – are recognisable by their sucking beak or rostrum, through which they feed on plant or animal juices. The rostrum is often held out in front when the bugs walk around feeling for prey, but when not in use it lies along the underside of the body. Bugs of the Hemiptera have an incomplete metamorphosis, from egg to nymph to adult.

Most species feed on plants, although quite a number supplement their diet with the juices of soft-bodied insects and some – such as the shield bug *Picromerus bidens* – are entirely carnivorous. A group of families of land bugs are also carnivores or blood-suckers. The assassin bugs (Reduviidae), damsel bugs (Nabidae) and flower and bed bugs (Cimicidae) are all British families.

Hunter bugs Assassin bugs are, in the main, a large tropical group, although six species are British. They are big, active hunters, seizing their prey with their front legs (which act like a jack-knife), then thrusting in their rostrum which, in this family, is stout and curved. Their saliva is venomous and is injected into the living prey, both to paralyze the victim and to start digestion of the tissues. The bug then sucks in the liquefied meal.

Reduvius personatus is sometimes called the flybug because of its habit of flying to lights in the summer. The blackish adult is quite large, and both it and the nymphs live in and around houses and outhouses where they feed on silverfish, flies, bed bugs, harvestmen and other small animals. Eggs are laid from June to September and the young nymphs, which hatch in about three weeks, promptly cover themselves with dust as a camouflage – repeating this action after each moult. This habit has led to them also being known as 'masked bugs'. They are not very common, having been recorded in England south of Lancashire only. Their life cycle takes one or two years, depending on when the eggs were laid, and adults are seen from May to September. If you find one, handle it with care as it can give a severe bite.

The heath assassin bug is a commoner species. It is much smaller than *Reduvius personatus*, and is blackish with paler markings. Usually short-winged and unable to fly (although long-winged specimens are found occasionally), it can be found on the more open parts of heaths and sand dunes where it hunts on the ground for spiders and insects.

Adults can be found from July to October on suitable ground throughout Britain, but not in Ireland. The eggs are laid in crevices in leaf litter and among moss, where they overwinter to hatch in the spring. The nymphs take two months to mature, and if either nymphs or adults are handled, they stridulate loudly.

Predatory damsel bugs The quaintly named damsel bugs, whose delicate form belies their

Above: The carnivorous shield bug *Picromerus bidens* has distinctive thoracic spines and a long rostrum, which it is using to suck the juices from this sawfly larva.

Right: The bed bug (*Cimex lectularis*) is a nocturnal insect which comes out at night from its hiding place in beds, behind pictures and skirting boards, or in cracks and crevices in the wall, to seek a blood meal. It can, however, survive starvation for many months.

Above: *Reduvius personatus*. Up to 17.5mm (¾in) long. Found around houses, May to September.

Above: **Heath assassin bug** (*Coranus subapterus*). Up to 12mm (½in) long. On open heaths, July-Oct.

Above: **Common damsel bug** (*Nabis rugosus*). Up to 7.5mm (⅜in) long. On grassland, Aug-Oct.

Above: **Ant damsel bug** (*Aptus mirmicoides*). Among grasses and plants, August onwards.

predatory habits, resemble the assassin bugs, and were once included in the same family. They are, however, rather smaller and feed on soft-bodied plant-feeding insects such as aphids – being of some importance in keeping down the numbers of these destructive pests.

There are 12 British species, probably the most abundant being the common damsel bug, which occurs throughout the British Isles. Common damsel bugs are found in grassy situations, where they hunt among vegetation or on low bushes as well as on the ground. Adult bugs overwinter and mate in the spring, the new adult generation appearing from August onwards. They are pale fawn in colour and usually short-winged, although long-winged forms are found occasionally.

The ant damsel bug is common in southern England, Wales and Ireland but it does not occur in Scotland. You can find it among coarse grass, nettles and low plants in fairly dry places, including gardens. Its life cycle resembles that of the common damsel bug.

An interesting feature of this species is that the young nymphs bear a striking resemblance to small black ants such as the black garden ant (*Lasius niger*). This is due to a false waist produced by white marks at the sides of the otherwise dark body. The nymphs are also often found near ant nests, although two records of them within an ant nest are thought to be chance occurrences. The short-winged adult bug does not mimic ants and is active mostly at night.

Flower dweller The common flower bug is one of the commonest British bugs and occurs throughout the British Isles. The adults, which are dark brown with paler markings, overwinter in debris or under bark and come out in the spring, when they can be found on a wide variety of plants. They lay their eggs in the tissues of the undersurface of leaves, and the nymphs are mature by late June; there are sometimes three generations per year.

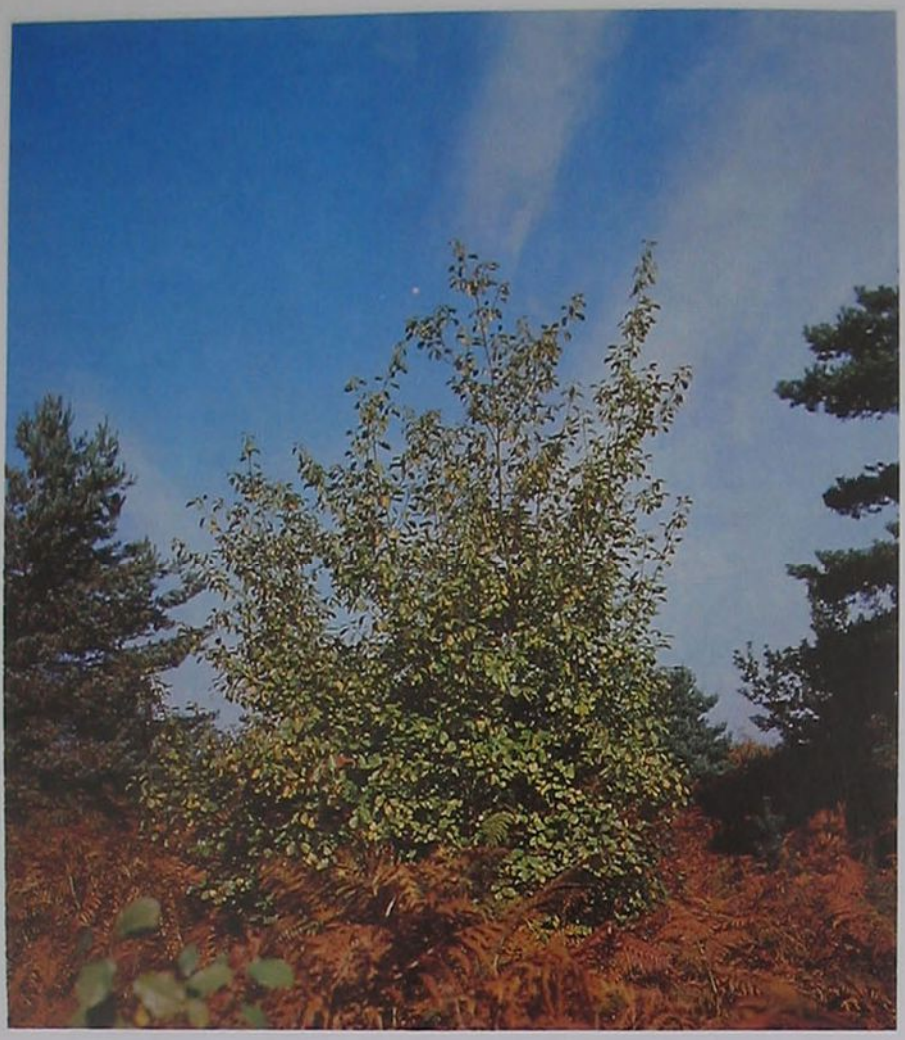
Human blood-suckers The bed bug is an unpleasant, wingless, blood-sucking insect. It is oval in shape, about 5mm (¼in) long and reddish-brown in colour. Both nymphs and adults feed on the blood of man and on that of various rodents, domestic and zoo animals. The females are long-lived and lay eggs in small batches after each blood meal. They may lay as many as 500 eggs over six months.

Left: The common flower bug (*Anthocoris nemorum*) is small and usually feeds on soft-bodied insects. This makes it useful to man, for its prey includes such pests as aphids and red spider mites. However, it is quite capable of dealing with larger insects, such as the hoverfly shown here, and may even give humans a sharp bite if handled.

The martin bug (*Oeciacus hirundinis*) is very similar in appearance to the bed bug and a common parasite of the house martin, in whose nests it lives. In winter, or when the nests are destroyed, the bugs may enter houses, living in crevices during the day and biting at night. However, martin bugs appear unable to complete their life cycles on human blood.

Due to modern insecticides, infestations by these bugs are now rare, and none of them is known to transmit disease.

Below: A mating pair of predatory marsh damsel bugs (*Dolichonabis limbatus*). They are commonly found in damp meadows and among rank vegetation. Rather darker in colour than the common damsel bug, they also have much shorter wings, which are reduced to tiny flaps in most specimens although fully winged forms are found occasionally. They are very savage and prey on flies, moths and ichneumons, and will even kill a spider if they should get tangled in its web.



THE THORNLESS BUCKTHORN

The only British buckthorn to lack thorns, the alder buckthorn is, for much of the year, one of our least conspicuous shrubs. The best time to find it is in the autumn when its black berries contrast with the red and yellow of its dying leaves.

Above: The alder buckthorn is most commonly a plant of open scrub, though it is sometimes found growing in deciduous woodland in the southern half of England. Until recently, alder buckthorn was an important source of high-quality gunpowder used in time fuses; in the gunpowder trade it used to be called black dogwood.

Alder buckthorn (*Frangula alnus*). Native deciduous shrub or small tree, growing to 4.5m (15ft) high.

The alder buckthorn is widespread throughout Europe and parts of Asia, yet in Britain it is only common in the south of the country–and even here its distribution is very patchy. In northern England and most of Wales apart from the far south, it is a much scarcer shrub; in Ireland it is rare and in Scotland it is almost entirely absent.

Despite its name, the alder buckthorn is entirely lacking in thorns. The 'buckthorn' part alludes to its close relative, the common buckthorn; together they are the only British members of the Rhamnaceae, the buckthorn family. The 'alder' part of the name was given to it by the early herbalists, who were persuaded by the shrub's straight, parallel leaf-veins into thinking that it was related to the alder tree. They were wrong but the name has stuck.

Fragile twigs The alder buckthorn is a deciduous shrub or small tree whose dainty appearance is due to its slender wide-spreading branches and twigs, and the sparseness of its foliage. The twigs are fragile and prone to snapping, hence the plant's generic name *Frangula*, which comes from the Latin 'frangere', meaning 'to break'. This quality is reflected in one of its English names, the breaking buckthorn, and also in its Welsh name 'breuwydd', meaning the brittle tree.

The bark can vary in colour from blackish to pale grey, but it is usually fairly dark. It is smooth, except near the ground where, with age, it roughens into slight vertical ridges. The twigs are dark purple and flecked with pale narrow lines of lenticels.

The leaves appear in April and are a shining green if the plant is growing in good light. They have a pointed oval shape with untoothed, often undulating, margins. Their most distinctive feature is their large number of straight parallel veins, quite different to the inward-curving veins on the leaves of the common buckthorn. In the autumn, the leaves turn red or yellow and hang downwards from the twigs before falling in October.

Flowers and fruits The tiny greenish-yellow flowers are borne singly or in clusters in the angle between the leaf-stalks and the stems. They open in late May and continue to appear throughout the summer, until the arrival of the first chills of September. Each flower has five, occasionally four or six, tiny petals ringed by an equal number of larger green sepals. Both male and female parts are borne in the same flower, unlike those on the common buckthorn, where the sexes are carried on separate plants.

Despite being so inconspicuous, the flowers attract bees, wasps and flies by their well-exposed nectar. Pollination occurs when these insects brush the five short dark purple stamens that are closely bent in towards the stigma.

The flowers are followed by berries. At first, these are green but by July the earliest ones have turned red and, by the end of August, violet-black. The berries are slightly larger than elderberries and contain two, sometimes three, seeds. They ripen and fall from September to November, depending on when during the summer the flowers appeared.

The berries are a useful source of food for both birds and mammals. Wood-mice carry them short distances and store them in little heaps. Pheasants also transport the berries but it is migratory thrushes that disperse the seeds over the greatest distances by shedding them in their droppings–these are often purple from the juice of the berries.

Patchy distribution A tree like the alder

Alder buckthorn

buckthorn has a patchy distribution because it has special ecological requirements not found in many areas. It occurs in a wide variety of habitats but they all seem to have in common a perennially damp soil, well-supplied with humus. For example, it grows particularly well in peat, except where it is perpetually waterlogged, and on the alkaline fen peats of the Norfolk Broads and undrained areas like Wicken Fen in Cambridgeshire the alder buckthorn is more prolific than anywhere else in the country.

The alder buckthorn also grows on heathland that has developed on lime-free clays or sands – a habitat that is characteristic of some commons in south-east England – and on limestone scrub areas, particularly in the Lake District and on the Burren Hills in the west of Ireland. On limestone extremely healthy specimens of alder buckthorn may be found growing in the wide deep fissures known as grikes.

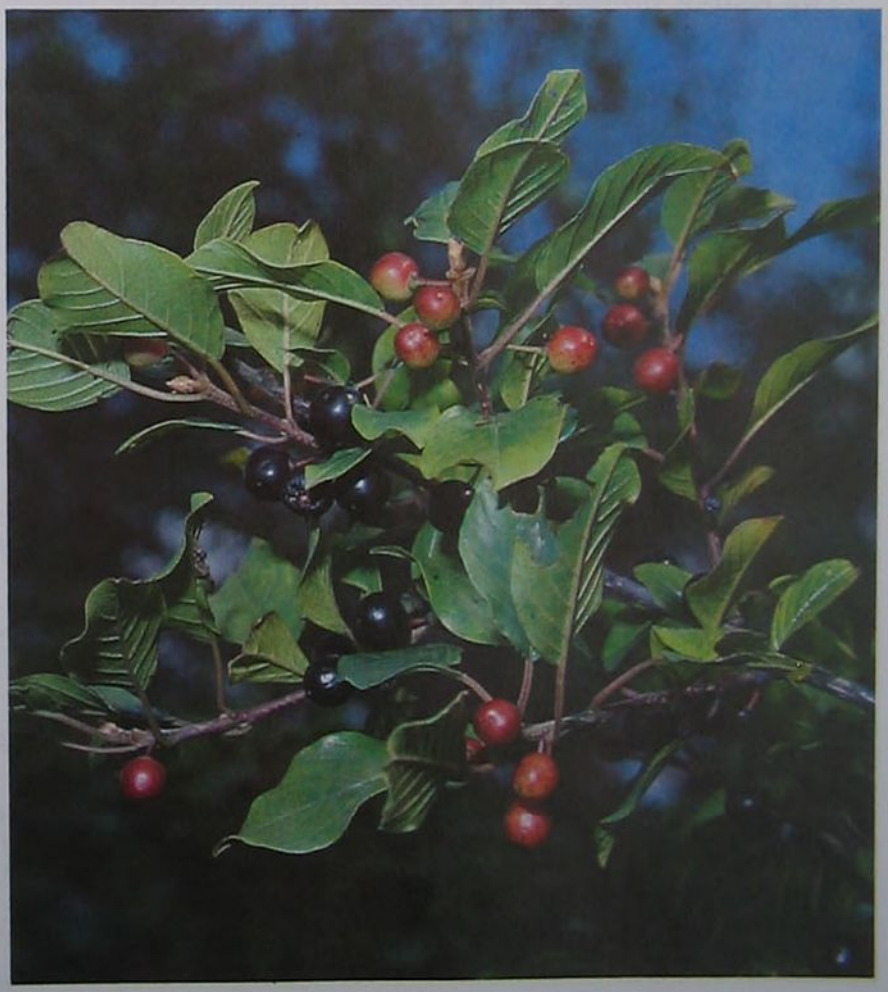
In all these habitats, alder buckthorn is a constituent of scrub where it usually enjoys a fair share of light overhead, despite its short size. But there are districts in the Midlands and the south of England where it grows in woodland undergrowth, usually scattered rather than forming thickets. In this habitat, alder buckthorn is most likely to be found growing along the banks of a stream. However, it often grows poorly in woodland. In heavy shade, particularly, it looks bowed, the leaves lack their usual gloss and the production of fruits is poor. Really deep shade may kill this shrub altogether.

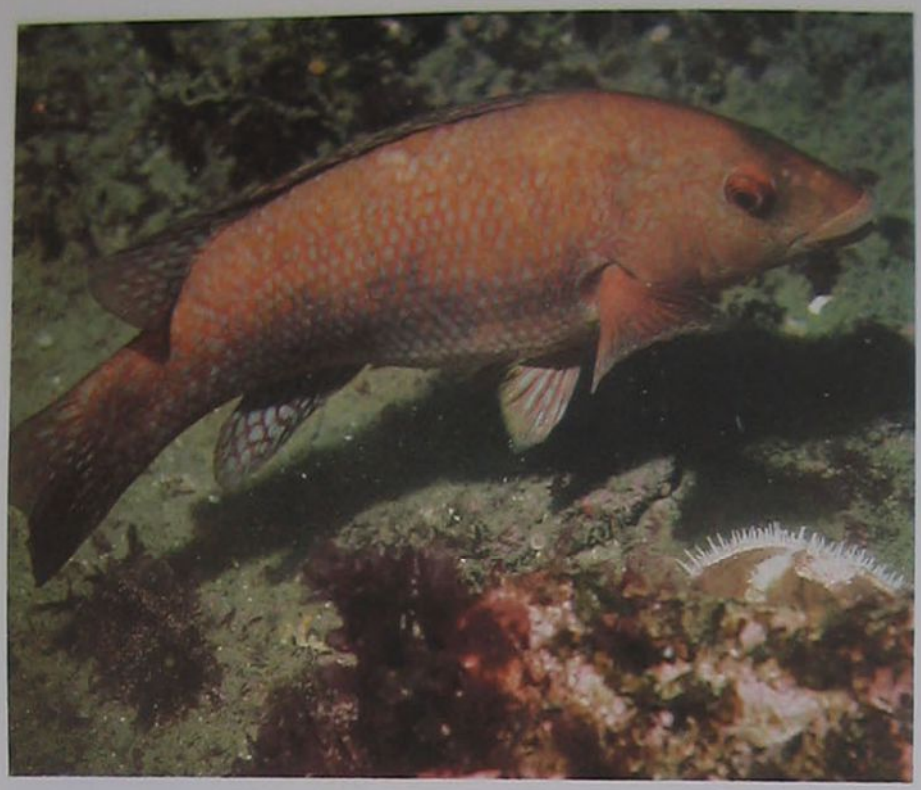
Future decline In the days when both forests and wetlands were widespread, the alder buckthorn was much more common than it is now, and it seems to be declining still, as woodland management and drainage become more and more efficient. It will certainly survive in nature reserves but it deserves also to be planted in wild corners on suitably damp soils because it is such an interesting and ancient member of our native flora. Moreover, in areas away from chalk or limestone, it is the only plant that one of our most attractive butterflies, the brimstone, will feed on.

Above: Alder buckthorn bears tiny greenish-white flowers in its leaf axils from May through to September.

Right: The leaves bear some resemblance to alder leaves but they lack the toothed margins.

Below: The berries ripen from green and red to violet-black. Since the flowering period lasts for so long it is possible to find berries at quite different stages of development on one plant.





THE BALLAN: OUR LARGEST WRASSE

The ballan wrasse is the largest and probably the most common of the British wrasses–a group of saltwater fishes. Like many others of its family, the ballan wrasse has the bizarre trick of changing its sex halfway through its life.

Wrasses are among the most colourful of all our saltwater fishes, and the ballan wrasse is no exception. The young are usually a beautiful emerald green and the adults are mostly either green or brown, though reddish specimens are not at all unusual. As with other wrasses, the body of the ballan wrasse is fully scaled, but on this species each scale has a paler centre and a darker rim, giving the fish a spotted appearance. The fins are also often spotted, especially during the breeding season, and sometimes a ballan wrasse is found with a white line running the length of its body.

The ballan is a very slow-growing species that lives to a great age. Fishes as old as 25 years have been caught and it is probable that, if left alone, they would grow older still. A length of 45cm (18in) and a weight of 1½kg (3½lb) are common, but specimens can attain 60cm (2ft) and 3½kg (8lb), making this species the largest British wrasse.

Rocky refuge The favourite habitat of the ballan wrasse is rocky areas, particularly cliffs and reefs, which provide a safe refuge. It can be found all around the coasts of Britain and Ireland, except for parts of the east coast. The ballan wrasse is very much a creature of habit and in some instances the same fishes, recognised by particular deformities, have been found in the same territory for several years at a stretch. At night the wrasse can often be found sleeping, wedged between rocks or hidden in seaweed; it can even be picked up before it swims off.

Above: Adult ballan wrasse are predominantly green or brown, though reddish specimens are not unusual and old males are often bright chestnut. All are spotted due to the scales having pale centres.

Being an inshore species, and common, ballan wrasse are a familiar sight to both divers and sea-anglers. Divers most often see it singly or in small groups, swimming through a kelp forest with a characteristic jerky rowing action of its pectoral fins. Adults venture down to at least 30m (15 fathoms) but they can also be found right up to the intertidal zone. Indeed, young ballan wrasse are very often found in rock pools, particularly those providing plenty of cover in the form of green seaweed (their green bodies blend in very well); occasionally, adults are also trapped in rock pools when the tide recedes.

Omnivorous feeders The ballan is omnivorous and eats almost anything available, though its food is composed mostly of animals, particularly molluscs and crustaceans. It also takes brittlestars, barnacles and, very rarely, small fishes or pieces of seaweed.

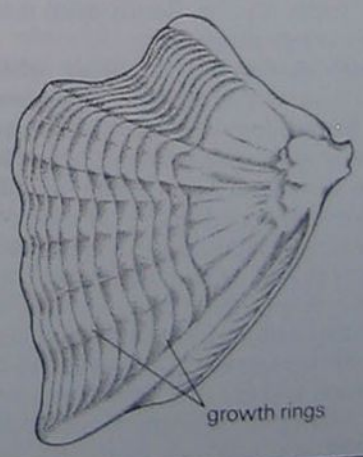
The ballan wrasse feeds by sucking in prey through its fleshy lips and then macerating it with powerful throat teeth–the teeth in its jaws are used to dislodge food from the rocks.

Anglers often find that they catch very few ballan wrasse during the winter months. This is partly because wrasse are less active, and so feed less, when the water temperature is low. They also appear to migrate offshore in some winters into deeper, warmer water to avoid the extreme cold near the coast, which can easily kill them.

Sex change The ballan wrasse has an extraordinary life-cycle. It has long been known that there are many more female ballans than males, and also that no juvenile males had ever been found. Furthermore, most males

Aging a ballan wrasse

The age of a fish is often estimated from the growth rings on the scales, but this is not the only way. Growth rings also occur on other bony structures, including the opercular bone covering the gill chambers. In the ballan wrasse this bone, once it is cleaned and dried, shows the rings clearly and is ideal for aging. The bone shown here comes from a twelve-year-old ballan wrasse specimen.



are more than 13 years old, though some comparatively young specimens around six years old have been found, and most of the really large old ballans are male.

The explanation for this strange situation lies in the curious life-cycle of the ballan wrasse. All specimens are born as females. They become sexually mature after about six years old and then begin spawning. However, after a few years, some individuals change sex and become fully functional males. There are no external differences associated with this change, only internal ones. This phenomenon explains why no young males are ever found, why most old fishes are males, and why there are many more females than males. There is no evidence to suggest that males ever change back into females at a later stage.

Sex change in other wrasses Many other wrasses–possibly even all of them–undergo the same strange life-cycle. In the case of another British species, the cuckoo wrasse, the process is accompanied by a startling change in colour. The female is a beautiful red with three black blotches, interspersed with white, near the tail. When she turns into a male, she loses these blotches and becomes predominantly blue, with a dark head and bright blue lines running along the body. The sides and belly often become a vivid orange. The two sexes are so different that they were for a time thought to be different species.

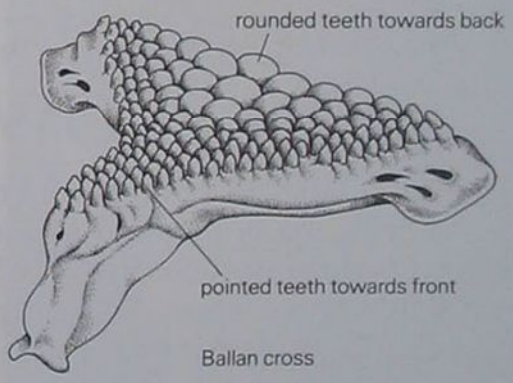
The mechanisms controlling these changes, in both the ballan and other wrasses, are not fully understood. It is known, however, that in some tropical species of wrasse the changes are controlled by social pressures operating through a system of dominance by larger, older males. When a dominant male dies, his place may be taken by a large female, who then changes sex to become the dominant male.

Spawning and young Little is known about the spawning behaviour of the ballan wrasse. The female builds a nest of fine algae, usually wedged into the crevice of a rock, and lays her eggs in it. These are then fertilised by a male. Since there are far fewer males than females, it is likely that each male has several females nesting in his territory.

After hatching, the larvae drift for a while, then develop into young fish and settle in rock pools and other shallow water. Small ballan wrasse can be found in rock pools from June onwards each year.

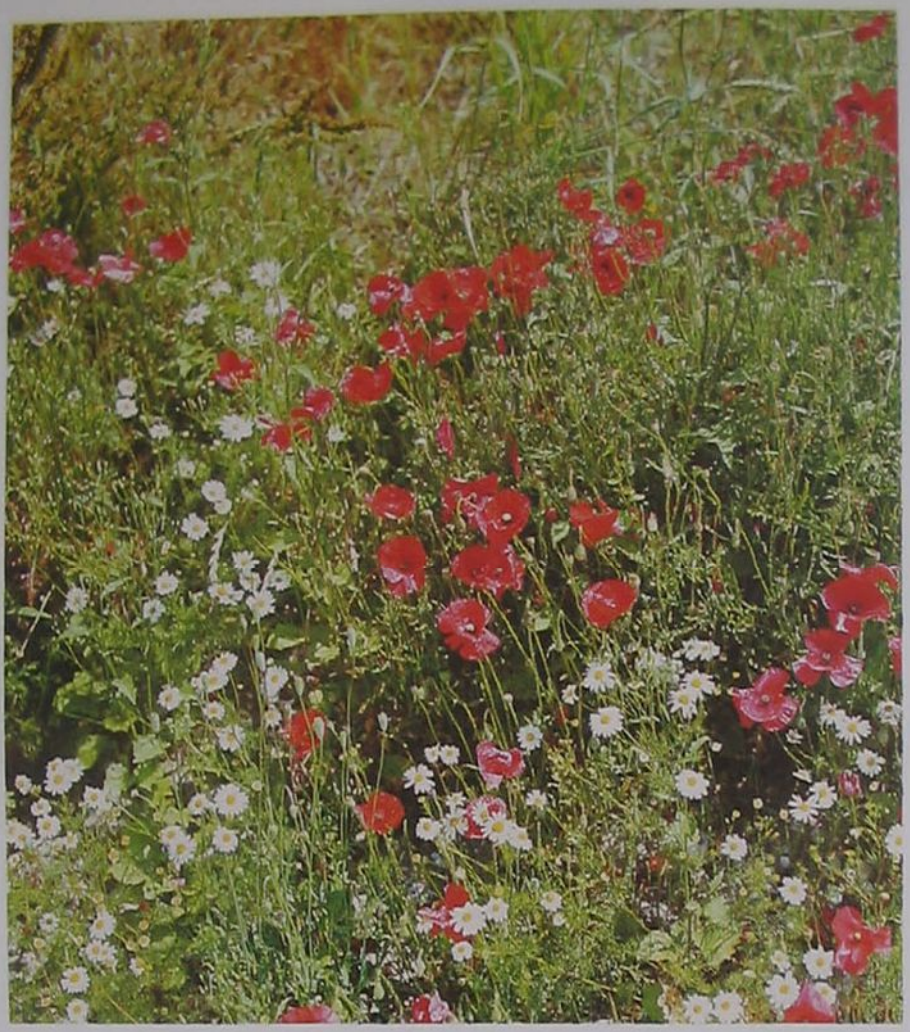
Vulnerability The ballan wrasse's strange life-cycle, and its territorial habits, make it extremely vulnerable to spear-fishermen who, by going after the biggest specimens, can soon remove all the males from an area. The problem is made worse by the ballan's great curiosity, which allows it to be quickly persuaded to feed out of a diver's hand. It is to be hoped that its curiosity does not lead to a decline in numbers of this charming and beautiful fish.

Above: The ballan wrasse remains the same colour as it changes sex, but the cuckoo wrasse undergoes a startling colour change from red to blue.



Right: The lower set of throat teeth is known as the ballan cross because of its shape. It is sometimes carried by sailors as a charm to prevent drowning.

Below: A rocky coastline with reefs to provide a safe refuge is the preferred habitat of a ballan wrasse.



DIVERSITY IN FLOWERS

Drab, dangling catkins, the nodding flowers of bluebells, many-petalled, colourful roses – why do flowers display such diversity? The answer is that each flower is a special structure designed to ensure successful pollination by one of a variety of means.

Above: Flowers have a wide range of forms for a variety of purposes. The more colourful flowers are 'advertising' themselves – the poppy may shed its red petals after only one day but their colour will have helped to attract bees and other insects for pollinating purposes. The flowerheads of scentless mayweed are really condensed inflorescences made up of two kinds of flowers – yellow disc florets and white ray florets – but usually only the disc florets produce pollen.

Flowers occur in many shapes, sizes and colours, yet essentially they are all composed of the same few structures – sepals, petals, stamens and pistils – arranged in four whorls. However, the incredible diversity in flowers occurs because the individual structures are remarkably variable; some of them may even be reduced or absent in certain species.

The sepals, which are typically green and leaf-like, make up the outer ring of a flower and their rôle is basically to protect the flower while it is in bud. Sometimes the sepals are supplemented with green scales or bracts, or they may be petal-like in colour and form, as in a wood anemone.

The petals are usually the most obvious and colourful structures and their main purpose is to attract insects. They are noticeably reduced in wind-pollinated flowers.

The stamens – the male parts of the flower – are made up of anthers usually borne on the tips of the filaments. The anthers produce the pollen containing the male sex cells and are arranged in such a way as to facilitate the dispersal of pollen by either wind, water or animals.

The female portion of the flower, the pistil, consists of three obvious parts; the stigma, the style and the ovary. The egg cells (ovules) develop within the ovary. The stigma is the receptive surface on which the correct pollen grains are recognised chemically and eventually germinate, producing a pollen tube which grows into the style, a conducting channel between the stigma and the ovary.

The four floral whorls all develop upon a special region – the receptacle – at the end of a flower stalk. The receptacles show varying degrees of fusion. At one extreme, in flowers such as the buttercup, there is only one receptacle, bearing a single flower. At the other extreme, in flowers of the daisy family, many receptacles are joined together and each head is really a mass of individual flowers called florets.

Flower variations Although the basic flower structures remain essentially the same, there are variations in all four whorls of the flower.

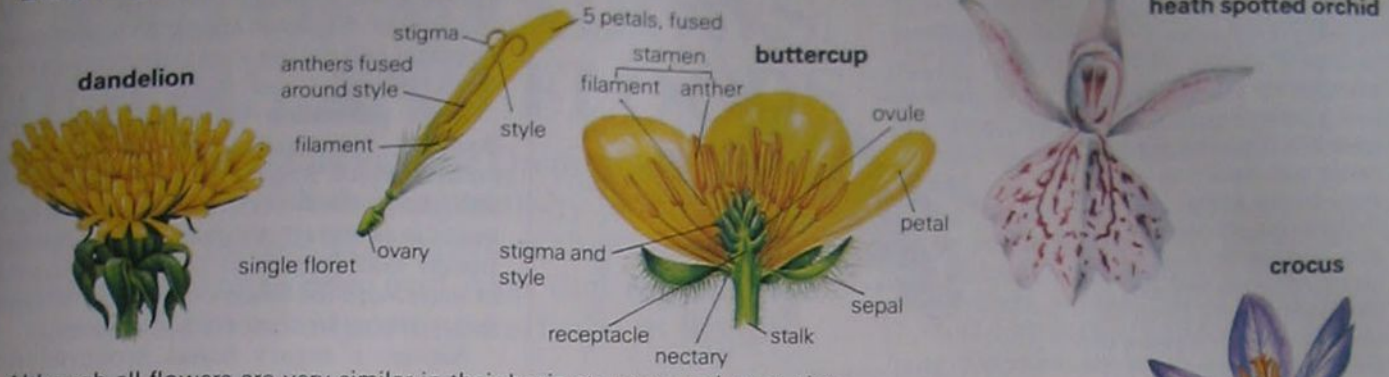
The most spectacular modifications occur in the petals, ranging from the simple, radially symmetrical flowers of a buttercup to the relatively complex, bilaterally symmetrical flowers of a snapdragon. In the snapdragon the petals are fused together and the stamens and ovary are hidden and protected inside a long tube. Catkin-bearing trees exhibit even more spectacular modifications, for the petals are completely absent and the male and female parts frequently occur on separate flowers.

Structural diversity is not confined to shape but can also apply to numbers of parts. A single male willow flower, for example, has only two stamens, while in a single paeony there are thousands.

Pollination The flower is the site where sexual reproduction takes place. Pollination occurs when pollen is transferred from an anther to a stigma. Self-pollination occurs when the pollen grows down from the stigma through the style and fertilises a flower on the same plant. Cross-pollination involves the movement of pollen from one plant to another. The advantage of cross-pollination within a species is that by fusion of the genetic characteristics of the two plants, vigorous new individuals, each with a unique genetic make-up, are produced. Any inherent weaknesses in a plant tend to be perpetuated and enhanced by repeated self-pollination.

Self-pollination is disadvantageous and, as a result, there are various isolating mechanisms to prevent it taking place. In herm-

Flower structure and form



Although all flowers are very similar in their basic structure and parts, they have evolved in many different ways, exhibiting a wide variety of forms and characteristics, often resulting in a specific structure.

Pollen protection Some plants, the crocus for example, protect their pollen during the night by closing their petals against the dampness and the dew. Individual bluebell flowers probably hang down for the same reason.

Sepals as petals Appearances can be deceptive, for although the wood anemone appears to have white petals, these are in fact sepals and the flower has no petals at all.

Recognising advanced flowers In comparison with the simple flower of the buttercup, for example, the flower of an orchid is relatively advanced, or highly evolved. It is symmetrical, so that if the flower is split vertically down the middle, the left and right halves are identical. Fusion of parts is considered to be another advanced feature; hence the bluebell, with its fused ovaries, and sepals and petals joined to form the familiar bell, is an example of a modified flower.

aphroditic plants these range from chemical recognition of pollen type at the point of contact between the pollen and stigma, to male and female parts maturing at different times. In species where the male and female flowers mature at the same time, the correct pollen has a chemical 'key' which fits the chemical 'lock' of a female so as to allow growth of the pollen tube into the female stylar tissue. This prevents 'foreign' pollen from inadvertently fertilising the 'wrong' flower.

An example of a double safeguard against self-pollination is when the male stamens of maize not only mature at least a day before the female flowers, but also grow on quite different parts of the plant. The male tassels appear at the top of the plant, while the female cobs are lower down, in the leaf-axils.

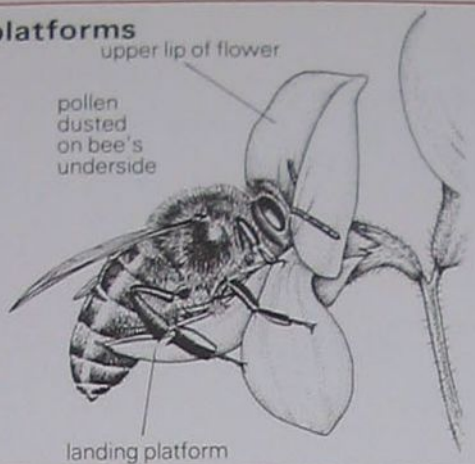
Pollination methods Although some plants can be pollinated by water-borne pollen, pollination is carried out by two main agents – wind and animals. Many theories have been advanced as to why plants have evolved so many colourful and diverse types of flowers. One possibility is that animal pollinated flowers co-evolved with the animals, along different lines of descent from their more drab, wind-pollinated ancestors. It is also possible that, along other lines of descent, fluctuating weather patterns favoured the evolution of wind pollination, and that specialised catkins

Right: To ensure the speedy and efficient liberation of pollen from wind-pollinated flowers, the stamens often protrude from the flower, as in the ribwort plantain (*Plantago lanceolata*).

Below: Bumble bees are very important pollinators. As they visit each flower in search of nectar and pollen, their hairy bodies become dusted with pollen grains which rub off when they visit the next flower, ensuring cross-pollination.

Flowers with landing platforms

The wing-like petals of leguminous flowers such as bird's-foot trefoil provide a landing platform for insects; only heavy insects such as bees can open the other petals sufficiently to gain entry to the nectar. Pollen rubs off on to the bee—against its back in arched flowers like the dead-nettle, and on to its undersurface in flowers of the clover family.



Left: The flowers of the bee orchid bear a striking resemblance to the insect, so that the male bee attempts to mate with the flower, mistaking it for a female and acquiring pollen in the process.

Below: In the arum lily or cuckoo pint, the structure we recognise as a 'flower' is in fact an entire floral shoot. The separate male and female flowers are borne on a fleshy shoot or spadix, surrounded by a sheath-like bract. Flies are attracted by the unpleasant smell of decay and crawl down to the base of the spadix, where the female flowers are found. If these flies have pollen from another arum on them, cross-pollination will occur.

had ancestors with more 'typical' flowers.

Insects are the most important of the animal pollinating agents. Many groups of insects pollinate flowering plants, although the bees and wasps and the butterflies and moths (the Hymenoptera and the Lepidoptera) are the most common. These two orders of insects have special structures on their bodies for their rôle as pollinators—the pollen baskets on the legs of bees, for example, and the long, coiled sucking mouthparts of the Lepidoptera. The type of pollinator depends very much on the structure of the flower concerned.

Wind pollination This method relies heavily on chance, and much larger amounts of light, dry pollen are produced than in insect-pollinated species. It is the high pollen count from wind-pollinated plants such as grasses that causes so much distress to hay fever sufferers.

Typically, wind-pollinated flowers have large, dangling anthers. The most significant feature is that the pollen is always presented outside the flower, freely available to the wind. The absence of petals and sepals helps to ensure airborne dispersal. Catkins, for example, are normally produced early in the year before the leaves appear to hinder pollen dispersal and during a period when winds are often strong.

Insect pollination Unlike wind-pollinated flowers, insect-pollinated flowers have anthers which frequently present the pollen well inside the flower, so that a visit by an insect is necessary to guarantee pollination. Insects visit flowers to collect either pollen or nectar and the flowers 'advertise' to attract these visitors by their colour or scent.

Nectar, a sugary liquid produced from nectaries situated at the base of the petals or at the sides of the ovary, is particularly attractive to insects as a food source.

In many insect-pollinated flowers the shape of the entire flower, especially the petals, ensures that the insect must enter along a certain pathway to reach the pollen or nectar. In so doing, it rubs against the reproductive parts of the flower and thus ensures transfer of pollen from one flower to another.

Some flowers have very specific pollinators and seem to discriminate against the type of insect that can gain access to the nectar or pollen. Certain flower species, for example, have long corolla tubes with nectar that is only accessible to long-tongued insects, such as hawk-moths.

Some orchids have very restrictive pollination mechanisms. They produce only two pollen packets (pollinia) and rely on one visit by one specialised insect to effect pollination.

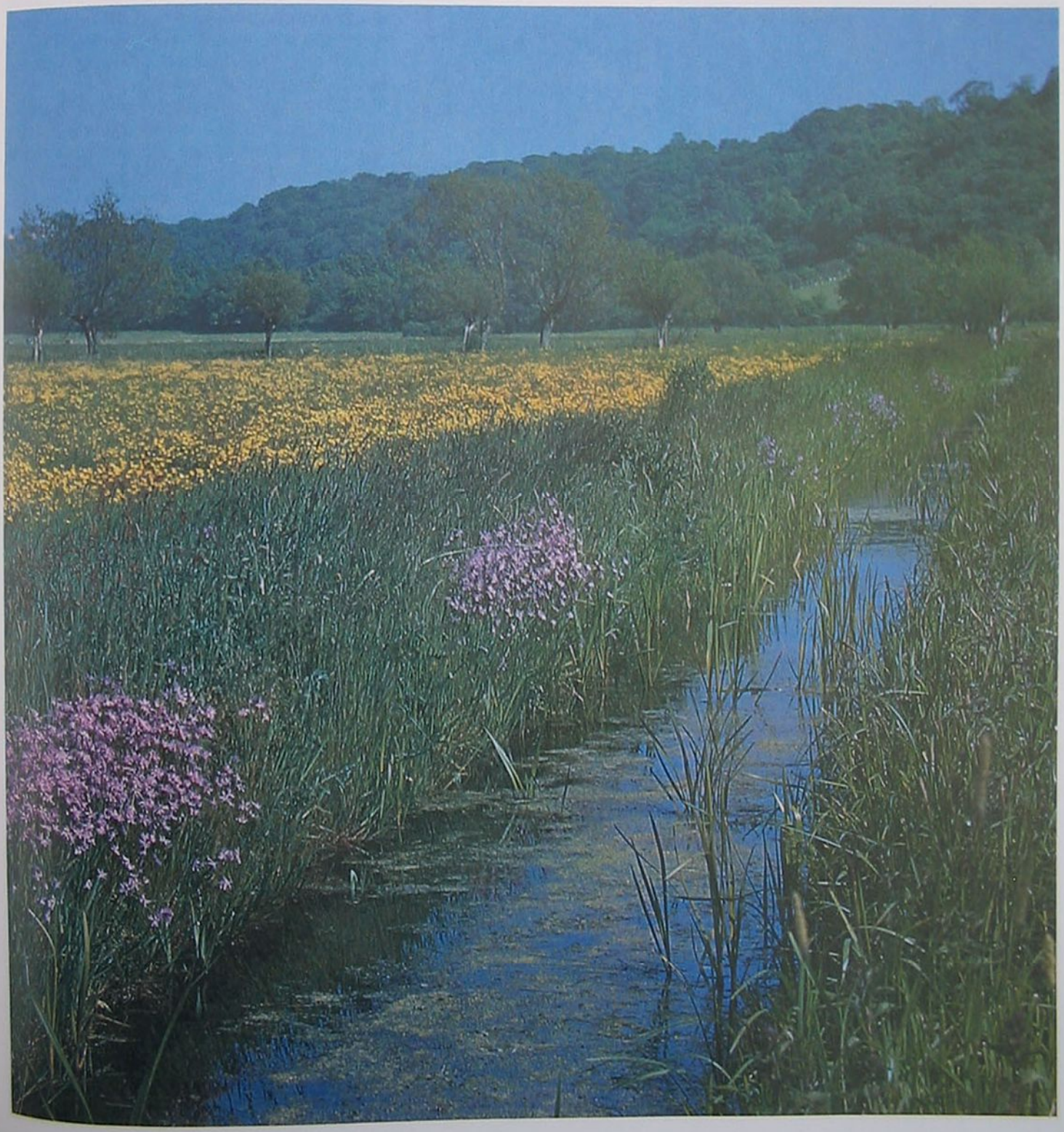
Many flowers protect their pollen or nectar from rain or heavy dew. The simplest device is for the flower to shut at night, as in the crocus, or to have flowers which hang down naturally, like those of the bluebell.

LAND OF MEADOWS, MOORS AND FLOODS

Between the Mendips and the Quantocks there is an enormous area of low-lying marshy land known as the Somerset Levels. It consists of the flood plains of the Rivers Parrett, Brue and Axe, that together form one of the most important wetlands in Britain.

Strictly speaking, the area generally known as the 'Somerset Levels'–covering some 57,000 hectares (140,000 acres)–consists of two quite distinct areas: the Levels themselves are an 8-9½km (5-6 mile) wide belt of land running along the coast, while the remaining low-lying valleys inland of this, mainly covered by peat, are known as the Somerset Moors.

The greater part of the Moors is barely above sea-level, except for the various hills and 'islands' (including Glastonbury Tor) within them, yet the coastal levels are some 2-3m (7-10ft) higher, because of a thick capping of marine clay laid down during Roman times. Inevitably, this capping acts as a



Above: Parts of the Somerset Moors consisted of acidic raised bog, and there has been a long history of peat cutting in the area. Peat is still cut today, using modern methods and machines.

Previous page: Flower-filled meadows bordering a rhyne – a drainage channel – in Sedgemoor in June.

Left: Bog pimpernel, easily identifiable by its small, pale pink flowers, is one of the rarer plants worth searching for on the Moors.

dam, hindering the free drainage of water from the Moors into the Bristol Channel – a difficulty made greater because of the huge tidal range of the sea here (the second highest in the world). High tide levels can be over 3.6m (12ft) higher than the level of much of the moors, and – although the sea is prevented from actually flooding across nowadays – this stops the rivers from discharging their load for up to four hours at a time.

The obvious consequences of this unusual physical situation are, first, that the rivers are prone to flooding in times of heavy rainfall, especially if this coincides with a period of high tides; and secondly, that the water table throughout the Moors is kept high and often very close to the surface. Although the rainfall on the Moors and Levels themselves is quite low, their catchment area is much larger and includes such areas as the South Mendips which has quite a high rainfall. The volume of water reaching the moors during a wet period can, therefore, be very large, and the existing network of rivers, channels and ditches (known as rhynes) is simply inadequate to hold it.

Parts of this huge area were once acidic raised bog, well above the level of the more calcareous ground water, but now only small, incomplete fragments of this occur, at Shapwick Moor, for instance.

The value of the area to wildlife and nature conservation lies in two spheres, one par-

ticularly dependent on winter flooding, the other on a high summer water table, though naturally the two are interlinked.

Winter flooding In winter parts of the Moors flood frequently. This can happen either because the rivers become full and water from the adjacent land can no longer be pumped into them; or because they become overfull and burst their banks. The net result is broadly similar, except that the latter is more devastating to agriculture and tends to be deeper over a wider area.

In a good year (ornithologically speaking) these vast flooded areas over pasture attract enormous numbers of birds, feeding both on the invertebrates brought close to the surface and on the seeds of submerged plants. The area was once particularly important for wildfowl, though it is somewhat less so now. Today, the area as a whole still attracts sizeable numbers of Bewick's swans, together with large flocks of wintering teal, mallard, shoveler and wigeon feeding particularly on the meadow plant seeds. At the same time, huge numbers of waders, especially lapwings, golden plover, whimbrel, snipe, dunlin and ruff, are attracted to the shallow flooded areas by the invertebrates close to the surface. There are also large wintering flocks of thrushes over the Moors, feeding along the hedges or in the drier pastures.

Flower-filled meadows As the winter floods subside, and the wintering or passage birds leave for their summer breeding grounds, the Moors take on a new aspect. The main land use of the meadows is for hay, followed by grazing, and by late May or early June the richer meadows are a blaze of colour.

Above: A flock of Bewick's swans overwintering on the Somerset Levels near Long Sutton. They, and a whole host of other birds, come to the Levels in winter to take advantage of the mass of invertebrates brought up near the surface by flooding. They also feed on the seeds of submerged plants. In summer the overwintering birds leave for their various breeding areas and the meadows are cut for hay and then grazed.

Because of the differences in soil (particularly whether there is clay over the peat, its depth, and if it is calcareous), and in water levels and past management, no two meadows are exactly the same. Some may be full of orchids, including the southern marsh, fragrant, frog and green-winged orchids. Others may be dominated by tussocks of purple moor-grass and bushes of bog myrtle, often with masses of meadow thistle and heath spotted orchids poking through the green carpet. Elsewhere, where remnants of the old raised bog still exist, a more acidic, heathy vegetation has developed, varying from acid grassland through heath to areas of wet bog. In these situations a whole group of uncommon plants occurs, including marsh pea, marsh fern, lesser bladderwort and milk parsley. The richer parts of the Moors also support sizeable concentrations of breeding birds, particularly waders, for which it is reckoned to be the best area in south-west England. The main species seen there are lapwings, redshanks, snipe and curlews, though there are rarer waders, too. At the same time the Moors are important for their sizeable breeding populations of whinchats and yellow wagtails.

The drainage ditches The rhynes between the fields are another vital part of the tapestry of the Moors. Traditionally, they are managed by being cleared of vegetation every four or five years. This is ideal for wildlife, providing a patchwork of vegetation at different stages. Some are almost stagnant, while others are faster-flowing, and overall almost all of the water plants that could occur in southern Britain do so somewhere or other in the rhyne or river systems of the Moors.

Of particular interest are sizeable populations of the rare rootless duckweed, the beautiful flowering rush, frog-bit, fine-leaved water dropwort and the water violet. A ditch at the right stage of its clearance cycle can be teeming with flowers.

Left: Perhaps one of the most striking features of the present-day landscape of the Levels is the vast interconnecting system of open drainage ditches—rhynes—which are now of such value to wildlife. Although some are very old in origin, the great majority date from the 18th century, as part of the general pattern of enclosure. The total area of this unusual wildlife resource, including the main ditches and rivers, is estimated to be about 610 hectares (1500 acres). Many of the rhynes are lined with pollarded willows, as in this picture.

Right: Another plant to look for on the Levels is the adder's tongue fern. This strange-looking plant, which flourishes on damp grassland, bears spore cases on the top 4-6cm ($1\frac{1}{2}$-$2\frac{1}{2}$in) of the stem. Its supposed similarity to the tongue of a snake led people to believe that this plant could cure snake bites—unfortunately not true.

Above: Birds like this brightly coloured shoveler are attracted to the Levels to feed on the seeds of meadow plants.

Left: A wet grazed meadow on the Levels. Growing here are devil's-bit scabious, bog myrtle and purple moor-grass. A small tortoiseshell butterfly is one species that feeds on nectar from a scabious flowerhead. Fields such as this will disappear if modern drainage and agricultural schemes are allowed to take over.

Not surprisingly, this extensive aquatic system, with its myriad plants, is an excellent place for invertebrates. Work is still going on to ascertain the total range of species, but the Moors are well-known as a nationally important site, and there are particularly good numbers of dragonflies and damselflies, water beetles and spiders. The wealth of invertebrate and fish life, together with the lack of disturbance, has enabled one of Britain's rarest mammals–the otter–to survive. The Levels and Moors seem to be one of the main strongholds for the otter in England, though it is heavily dependent on the present agricultural regime and water levels for its food and cover.

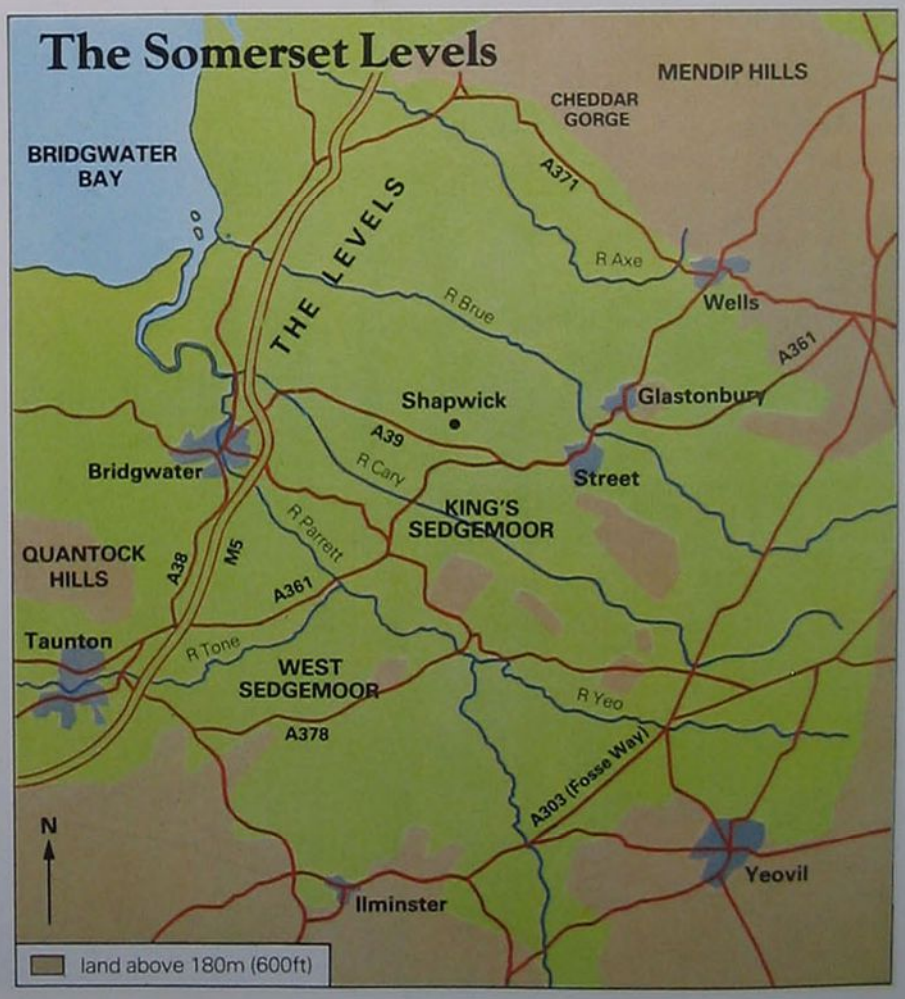
Agricultural change Wetlands throughout Europe are threatened by changes, mostly deriving from agricultural improvements, and the Moors and Levels of Somerset are no exception. Although their strange physical situation might seem to preclude major improvements, this is, regrettably, not the case, and several major drainage schemes have recently been proposed.

Much of the soil of the area is potentially very fertile, and could support more intensive use if it was drier. It is a relatively simple matter to under-drain fields to lower the water table locally, and grow a more productive crop, but if that area is liable to flooding at any time during the cultivation period, the valuable crop will be destroyed. Hence, most farmers have not considered it worthwhile to drain their fields, although a number have done so in areas that are flooded less.

It is, however, now technically feasible to reduce the flood risk considerably by complex (and extremely costly) schemes, which will prevent all but the most unusual of floods. If such schemes go ahead, they will almost certainly spell the demise of the wildlife in the areas affected. Fields will be drained and ploughed, ditches will be deepened and kept clear and some will be piped to make way for larger arable fields; fertiliser and pesticide run-off will eutrophicate and deaden the rhyne flora and fauna; and birds would, of course, no longer come in such numbers in winter as there would be no floods to attract them.

The main cause for optimism, other than the abandonment of such schemes, is the fact that the moors are split up into innumerable small farms, and many farmers would not wish to change their present form of land use.

At the same time, many areas are undergoing change as the large-scale mechanised peat industry takes its toll and turns areas of old, herb-rich grassland or heath into shallow lagoons. Although peat extraction on this scale gives rise to the possibility of the creation of new habitats–such as the much-publicised Avalon Lakes scheme–many of the habitats it destroys are irreplaceable.



VINEYARDS AND WINE-MAKING

After centuries of neglect, the last 30 years have seen a resurgence in the British wine-making industry, fuelled by the development of new techniques, improved varieties of grape and an increasing demand in Britain for wine.

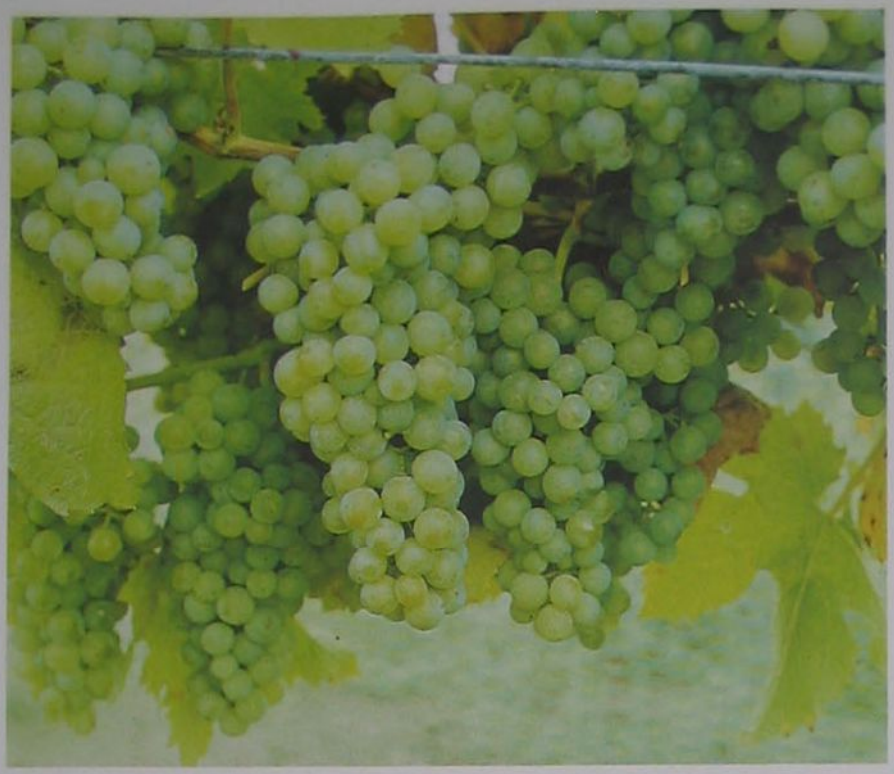
Above: A British vineyard, planted on a sloping hill to catch the sun. It is important to distinguish between English wine, made from grapes grown in Britain, and British wine, made from imported grape concentrate.

In Britain, wine is becoming an ever more popular drink, and consumption of light table wine in particular is increasing steadily. In 1969, we each drank four bottles of wine, on average; in 1975 this figure had gone up to seven bottles of wine, and to eleven by 1982.

Almost all the wine we drink is still imported but increasing amounts are being made in this country, and England is now seeing the regrowth of its own wine industry, which has been virtually dormant since Tudor times.

History of British viticulture Few people think of Britain as a wine-producing country, and certainly it has a modest output compared with, say, France or Italy. Nonetheless, it has a long history of viticulture.

Grape vines were first introduced to Britain by the Romans, who brought over plants from Italy and Greece. Vineyards were planted extensively in southern England and as far north as Lincolnshire. With the introduction of Christianity into Britain, wine continued to be important after the Romans withdrew from Britain during the 5th century. The Norman Conquest brought with it new French methods of wine-growing; in 1086 the Domesday Book recorded 46 vineyards in Britain, most owned by the Norman aristocracy. By the 12th century, wine was being grown as far north as Edinburgh and Durham, and wine was a universal drink not just restricted to the well-off.



Above: Almost all grape varieties grown in Britain are white since, in general, they require less sunshine than black varieties—an important consideration in our climate. Shown above is the most commonly planted variety in Britain—Müller-Thurgau. Where it finds the soil to its liking, this grape produces a fresh, pleasant white wine, though it seems not to be suited to all soils. Other widely planted varieties include Reichensteiner, Seyval Blanc and Huxelrebe.

Towards the end of the Middle Ages, wine-growing began to decline in Britain, probably due to a number of factors. Tastes seem to have changed and wine-drinking became less popular, and the climate became cooler, which discouraged many wine-growers. But the main blow to British viticulture came in 1536, with Henry VIII's Dissolution of the Monasteries. This severely reduced the area of land under vines and dispersed many expert monkish wine-growers.

On a much reduced scale, wine-growing continued for almost the next 400 years, but between 1920, when the Marquis of Bute's vineyard at Castell Coch near Cardiff closed, and 1956 no wine was made commercially in Britain.

Interest began to revive after George Ordish's success with planting vines privately in Kent in 1939. Further research followed on selecting the best varieties for the English climate, and a major landmark was undoubtedly the establishment in 1952 of a new vineyard by Sir Guy Salisbury-Jones. It began to produce wine four years later and its success encouraged many other people to set up vineyards. There are now about a hundred commercial vineyards in England and Wales.

Botany of grapes Virtually all the commercial varieties of grape vine belong to one species, known botanically as *Vitis vinifera*. This plant has been cultivated in Europe and parts of Asia for thousands of years, and where it originated from no one knows.

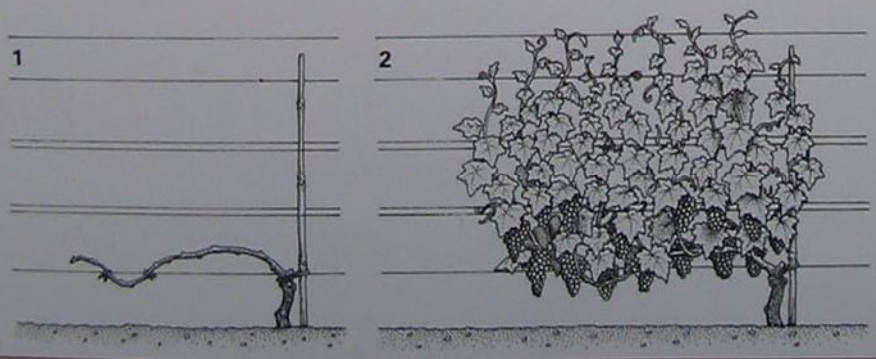
The grape vine is a climbing shrub that clings to its support with tendrils. The leaves are alternate and 8-15cm (3-6in) long with three to five coarsely toothed lobes. The flowers are very small and numerous, each with five yellowish petals and stamens attached to a cup-like calyx. They are borne on an inflorescence arranged in a cyme. The grapes mature in October, when they are either yellowish or black with a purple bloom. Each grape contains several seeds.

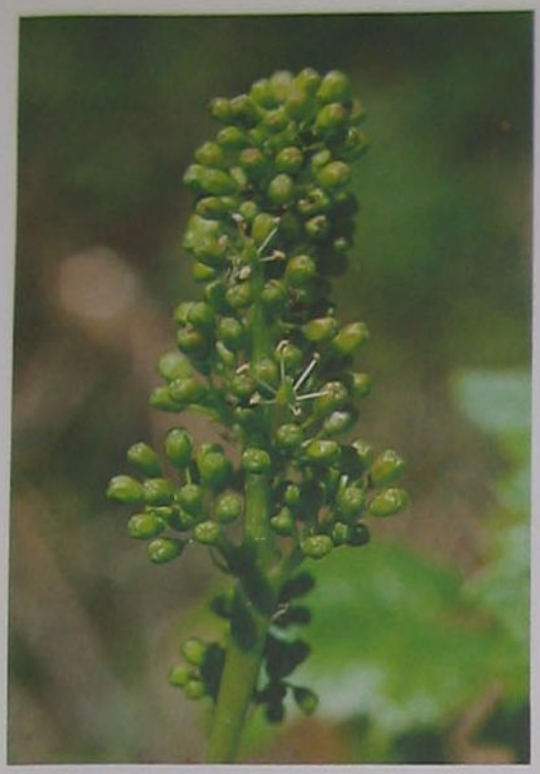
There are literally thousands of varieties of *Vitis vinifera* grown around the world but the British vineyard owner is restricted to those varieties that offer the greatest chance of ripening in our uncertain climate, yet still produce good-quality wine.

Weather and growing conditions Many people believe that the British climate is not suited to growing grapes outdoors, yet the history of wine-growing in Britain seems to disprove this. It is true that Britain is at the northern limit of Europe's wine-growing region, though many of the most northerly

Guyot pruning system

In England the most popular way of training a grape vine is by a method called the Guyot system. In this system newly planted vines are pruned to leave two buds. In the first season, only one shoot is allowed to grow; in the winter it is cut back to two buds. In the second season, again only one shoot is allowed to grow, but this time it is pruned in the winter to leave ten buds, and is then bent down and tied (**1**). In the next season, all these buds should develop and bear fruit (**2**). The pattern of branching can be seen best after leaf-fall (**3**). Shown on the right is a row of vines trained on the Guyot principle. The netting lower down is to protect the fruits.





Opposite: Grape vine flowers are yellowish and borne on large inflorescences. They appear in June and, at this time of the year, the wine-grower needs warm, dry weather to ensure a good crop. Rain at flowering time can ruin the year's crop by preventing pollination.

vineyards in Germany and France have less favourable climates than this country.

The two most important climatic factors are sun and rain. To maximize the amount of sunlight falling on a crop, vineyards are usually sited on a slope facing south-west or south-east, and at a low altitude. Lack of sunshine was responsible for the failure of many of the older varieties to ripen. Certain modern varieties ripen much more easily, though most are white since, in general, they require less sunshine to ripen than black varieties. This is why English wine is nearly all white – red wine can only be made from black grapes.

Rain is the other important factor. Britain has high rainfall during the summer, which leads to humid growing conditions for the vines and the possibility of fungal diseases such as mildews. But modern planting patterns and fungicidal spraying programmes can reduce the severity of this problem.

Rain and hail at flowering time can ruin a crop by preventing pollination and thus the formation of fruits. Similarly, too much rain in the later stages of ripening can dilute the sugars in the grapes, which spoils the wine – this happened in 1976. The ideal ripening condition is warm dry weather in October.

Vines are not particularly fussy about the soil in which they grow, provided it is reasonably well drained and not too rich, and they are also tolerant of cold winters.

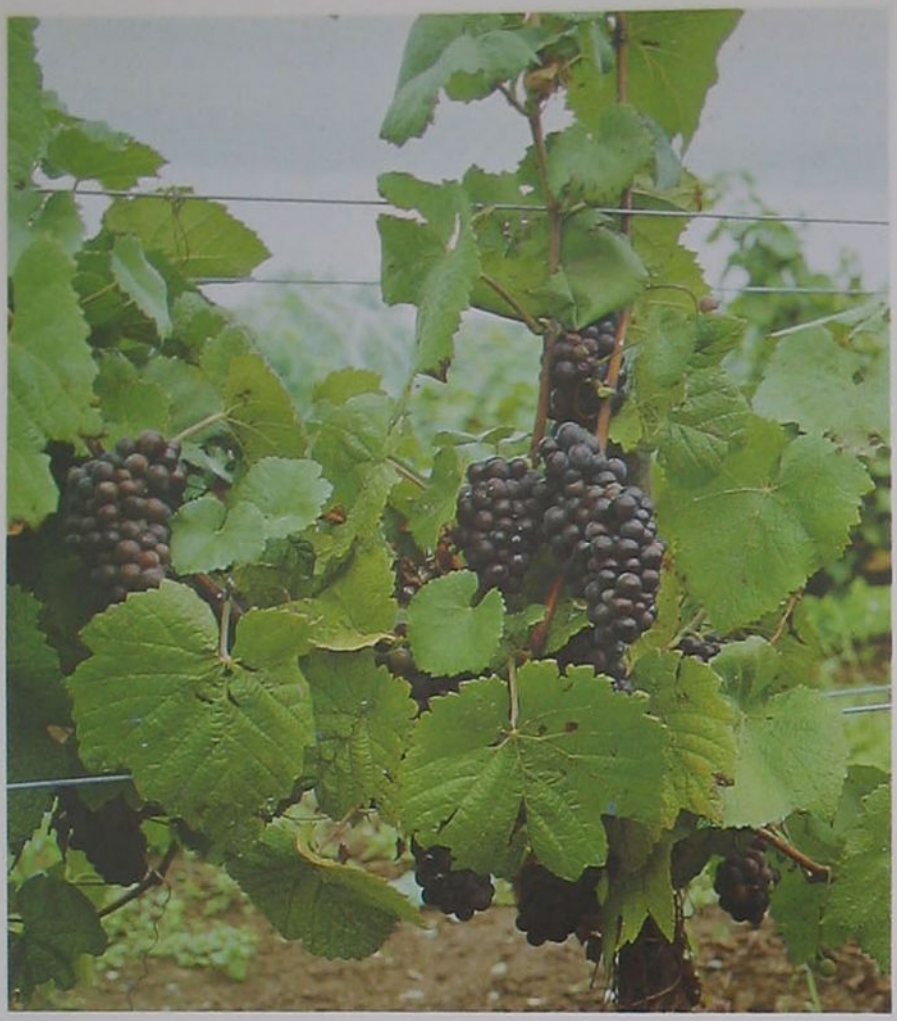
The wine-grower's year This starts in January when the previous year's growth is pruned. Pruning is essential since, left on their own, grape vines form huge straggling bushes as they climb up anything they encounter. This makes the crop difficult to harvest and affects its quality, and hence that of the wine. During the first few years of a vine's life it is pruned and trained to the required shape and size; after that, strict pruning is carried out each year.

In February, the pruning is complete and cuttings are taken for grafting on to rootstocks to form new plants. Until the last century, vines were grown on their own roots, but in the 1850s an American bug, *Phylloxera vastatrix*, reached Europe and had a devastating effect on European vines. This insect attacks the roots of vines and, over the next 30 years or so, all the major wine-growing regions were severely affected. Despite strenuous efforts to find a control, it was not until the end of the century that a solution was found. This was to graft European varieties on to rootstocks of vines from eastern North America, which were found to be highly resistant to phylloxera. All vines on the Continent are now grafted, though some in England are grown on their own roots.

In April, one-year-old vines are planted out and established bushes begin to show new growth. For the next month late frosts are a problem because they can easily damage the

Below: Birds are a major threat to ripening grapes. Blackbirds, thrushes and starlings are the main culprits and many growers find it necessary to net the vines as harvest-time approaches. Here, only the vines on the left have been netted; the ones on the right are too young to bear fruit yet.

Right: One of the larger English vineyards is at Elmham Park in Norfolk. The first vines were planted there experimentally in 1966. Five years later, the results were encouraging enough to establish a commercial vineyard and the first vintage appeared in 1974. Today, there are 4 hectares (10 acres) under cultivation. The main variety grown at Elmham Park is Müller-Thurgau, with Madeleine-Angevine a close second. The picture above shows rows of ripening grapes at Elmham Park. The church is an Anglo-Saxon cathedral and appears on their wine labels.



Above: Of the small quantity of black vines planted by British wine-growers, the most common variety is Pinot Noir.

Opposite: Müller-Thurgau vines grafted on to a rootstock. Since the outbreak of phylloxera during the last century, all Continental vines have been grafted on to rootstocks of North American vines, which are resistant to this pest. In Britain most, but not all, vines are grafted.

young shoots. Flowering occurs in June, and for the two weeks or so while the flowers are open fairly dry, warm weather is desirable, otherwise little fruit will form. After flowering, the shoots are thinned.

Throughout the year, but particularly during the summer, control of pests and diseases is important. Wasps can be a problem with early-ripening varieties and birds are a major threat, often requiring the grapes to be netted. Fungal diseases, such as grey mould, powdery mildew and dead-arm have to be kept at bay with a regular programme of spraying.

By October, the grapes should be ripe and ready to harvest. Once harvesting has begun, extra labour is almost always needed since the grapes must be picked as quickly as possible. Following that, the soil may be drawn up over the base of the vines and, in December, the winter pruning begins.

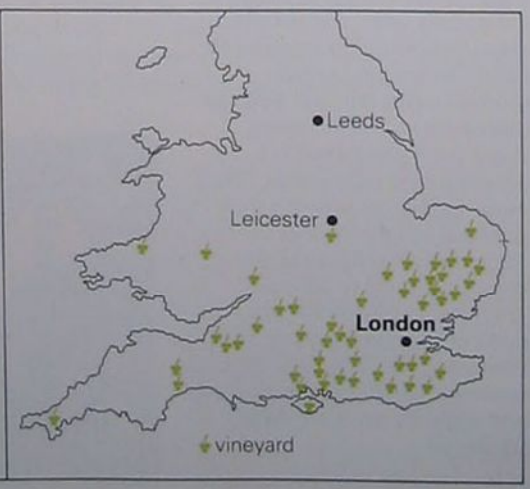
Wine-making Once the grapes have been harvested, they are first crushed and pressed, usually by machine. Sodium metabisulphite is then added to kill off wild yeasts, which would otherwise interfere with the fermentation. The resulting juice is called 'must'. It is adjusted for its sugar content and acidity, and then it is left to settle for a few days.

The next stage is the fermentation process. The must is siphoned off into a fermentation vessel and a liquid starter yeast is added to begin the process. The aim is for a fairly slow, cool fermentation; the process is normally complete after about three weeks. The sediment is allowed to settle and then the wine is siphoned off (or racked) and allowed to settle. Sulphur dioxide (usually in the form of metabisulphite) is added as an anti-oxidant and the wine is 'fined'–a process in which a chemical called bentonite is added to remove fine particles held in suspension and which give the wine a hazy appearance. After that, the wine is bottled and stored. It is ready to drink after about a year and should be drunk before it is four years old–English wines do not usually keep well for a long period.

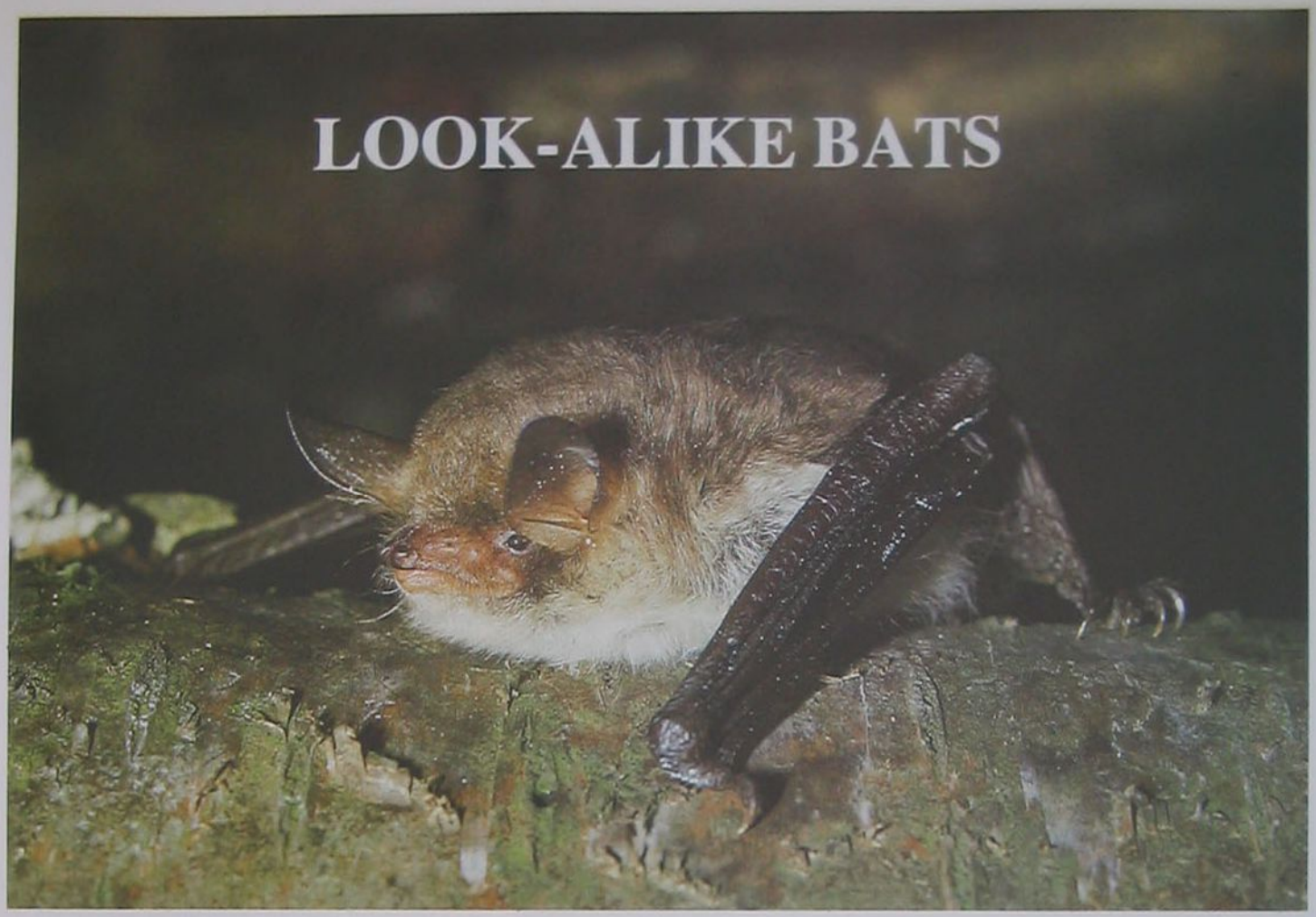
English wines Britain is now producing some high-quality wines, comparable in flavour to German wines, yet sales of English wines are handicapped by the present system of taxation in this country. In Britain, wine-producers have to pay the same rate of duty payable on imported wines, whereas in other EEC countries, home-produced wines pay much less duty and so can be favourably priced.

British vineyards

There are now about a hundred commercial vineyards in England and Wales, which is probably more than at any time since the end of the Middle Ages. More than 200 hectares (500 acres) are under vines in this country. Only the larger vineyards are shown on this map, though smaller vineyards are to be found as far north as Lincolnshire.



LOOK-ALIKE BATS



Above: A natterer's bat, a common *Myotis* species of woodland and parkland throughout the British Isles.

Below: The foot of a mouse-eared bat—a species now almost extinct. In the past archaeologists have been puzzled by scratch marks high up in caves. To begin with it was thought they might have been ancient tribal markings, but it is now known they are claw marks showing where bats lived in the past.

Of the six British species of *Myotis* bats, one is now effectively extinct, another is very rare, and a third is still in many ways an enigma; the other three are quite common.

In general, bats look rather similar, but some British species stand out from the rest—long-eared and horseshoe bats, for example. However, the six *Myotis* species—natterer's, Daubenton's, Bechstein's, mouse-eared, whiskered and Brandt's—are very 'ordinary' in appearance, and difficult to tell apart, and they comprise nearly half the British list of bats. Some, such as natterer's and Daubenton's are quite common and widespread. Others, such as Bechstein's, are rare and poorly known, and the mouse-eared bat is now almost extinct. It is important, especially for scientific conservation, that bats should be better known and understood and not simply overlooked because they are hard to recognise.

Myotis characteristics The first problem is to identify a species as a *Myotis* bat, not as some other kind of bat. *Myotis* bats have a simple dog-like snout with no cone-shaped nose leaf round the nostrils. Their ears are thin and delicate, two or three times taller than they are wide, but less than half the length of the bat's body. Their inner edges do not meet above the forehead. Most distinctive of all is the shape of the tragus: this is the thin spikelet of skin that sticks up like a little prong from the base of the ear. It projects across the opening of the ear, and extends more than half way up the ear flap. It is narrow and pointed; in many other bat species the tragus is absent, different in shape, or much shorter.

To separate the different species of *Myotis* bat is more difficult, and even confuses experts. The best way to set about it is on a comparative basis, in a careful and detailed scrutiny in the hand. It is difficult to be sure even then, but clearly identification of flying

Left: The whiskered bat, a small, common species of *Myotis* bat that is found not only throughout England and Wales but the greater part of Europe as well. Its fur is dark grey and its face is almost black. It is often seen around dusk, darting in and out among trees and both old and modern buildings. Under the 1981 Wildlife and Countryside Act it is an offence to disturb bats in your home unless they are actually in the rooms you live in.

Telling Myotis bats apart

WHISKERED BAT (above)
(*Myotis mystacinus*)
Notes A common species, especially around buildings, hedgerows, woodland margins. Most easily confused with Brandt's and Daubenton's; told from the latter by smaller feet and ears, different face colour.
Size Tiny.
Muzzle Dusky, almost black.
Ears Pointed and upright like a pixie, dark at base, almost black. If folded forward, ears will project beyond nostrils.
Fur Dark grey, but paler grey-brown in old animals. Belly fur is dirty white.
Foot Very tiny, about 8mm long and 3mm wide.
Tail Ends at heel.

BECHSTEIN'S BAT (above)
(*Myotis bechsteini*)
Notes Very rare in southern England, probably fewer than 60 British records this century.
A slow, low-flying bat of open woodland. Ears so long that natterer's is the only *Myotis* bat likely to be confused with it.
Size Medium.
Muzzle Pointed, brownish.
Ears Brown, very long. If you lay one forward it will fold around the end of the nose and still leave half its length free. Ears are half the length of head and body; only long-eared bats have longer ears than this species.
Tragus Just about half the length of the ear.
Fur Light brown on the back, off-white on underparts.

NATTERER'S BAT (above)
(*Myotis nattereri*)
Notes Common, especially in woodland and parkland. Flies rather slowly and not normally very near ground.
Size Medium.
Muzzle Long and pointed, face pink.
Ears Brown, but pale pinkish at base. Long—if you fold one forward it will extend well beyond the nostrils and wrap around the end of the snout. Ears one third length of head and body; longest of any *Myotis* apart from Bechstein's. Seen from head on, the ears appear to droop outwards and have turned-up tips, (contrast the upright, perky, pointed ears of the whiskered).
Tragus Long, two thirds the length of the ear.
Fur Light brown on back, pure white on belly, sharp dividing line between the two colours along side of neck.
Tail A conspicuous fringe of 1mm-long hairs at rear edge of tail. Hairs sprout from tiny swellings that look like a string of beads along trailing edge of membrane.

DAUBENTON'S BAT
(below)
(*Myotis daubentoni*)
Notes A common, low-flying bat most likely to be confused with whiskered.
Size Small.
Muzzle Short and broad. Face dull and brownish. Facial fur extends over forehead to eyes; overall impression is of a more snub-nosed bat than the other *Myotis* bats.
Ears Shortest of the *Myotis*. If one is laid forwards it will not reach tip of snout.

Tragus Half length of ear.
Fur Brown (often quite dark) on the back, shading to dull buff colour on the belly.
Foot Appears to be disproportionately large and broad; bigger than normal for bats. It is over half the length of the shin with toes that radiate outwards from a 'palm' (toes of whiskered bat appear more nearly parallel to each other).

MOUSE-EARED BAT
(above)
(*Myotis myotis*)
Notes A slow, heavy flyer. Effectively extinct in Britain as only two males are known to exist.
Size Very big and heavy—weighs 40g (nearly 1½oz).
Muzzle Face almost bare, pale pinkish brown.
Ears Big, broad; one fifth length of the head and body. If they are laid forward they extend about 5mm beyond the nostrils.
Tragus Half the length of the ear.
Fur Light grey-brown on back, greyish-white on belly; a distinct boundary where the two colours meet on the neck.

BRANDT'S BAT
(*Myotis brandti*)
Notes As this species is so similar to the whiskered bat, it is assumed that its general biology is similar too. Little information is available purely on Brandt's. It occurs in similar areas to whiskered. Key features include dark reddish-brown muzzle, short tragus—just less than half the ear. Folded ears project beyond nostrils. Reddish-brown fur, buff on belly.

bats (apart from Daubenton's), is impossible.

Size is a helpful guide but cannot be decisive, except with the largest one, because the species are similar in size and the range of measurements for one type of bat often overlaps the range of another. Some *Myotis* have distinctive specialities, such as the baggy tail of natterer's and the black face of the whiskered bat.

Identification may further be helped by a knowledge of the distribution and status of *Myotis* species. The mouse-eared bat is almost extinct, and Bechstein's bat is rare in southern and central England. Brandt's and whiskered occur throughout England and Wales, but the other two species are found throughout Britain except perhaps for some islands.

General biology All six species are, so far as is known, fairly similar in their general habits. They feed on insects caught on the wing, though natterer's may glean insects off foliage and Daubenton's picks up some of its food from the surface of the water.

All produce one young a year, and with luck live over 25 years. In early summer the females gather together in buildings and hollow trees to bear their young. The males live separately elsewhere. Sometimes nursery colonies number several hundred bats and are not uncommonly the cause of un-Christian ire when they choose to raise their offspring in the roof of a church.

During winter all British bats hibernate – in this way surviving without regular supplies of insect food. *Myotis* species often seek a cave, mine or other cool underground area. In the south-east especially, such places are hard to find and are frequently disturbed, so the bats may hibernate in old trees or other cool places. Each of these bats has a different preferred hibernation temperature; so even when caves are available, they do not necessarily all go there at once. Natterer's bats, for example, usually do not resort to caves until quite late in winter, while whiskered bats hibernate there from mid autumn onwards.

In common with other bats, these species are becoming scarcer due to loss of habitat, disturbance of roosting and hibernating sites and shortage of food. Yet many people do not like bats very much, so few care about their plight.

In fact they are probably in greater need of conservation than any other British mammals. It is now illegal to kill, catch, or interfere with bats. But attitudes need to be changed, as well as laws, to ensure that these interesting and beneficial creatures get the support and attention they deserve before it is too late.

Above: Bechstein's bat. Once the mouse-eared bat becomes extinct, Bechstein's will be a front-runner for the dubious title of 'Britain's rarest mammal'. It is of limited distribution and very scarce. It is found in an area of southern and central England from Dorset and Hampshire north to Shropshire.

Comparative sizes of Myotis bats

The biggest (mouse-eared) is – or was – Britain's largest bat; the smallest (whiskered) is only slightly bigger than the pipistrelle and among the smallest of all British mammals. Often body weight is a useful identification feature, but not in bats. They put on one third of their body weight before hibernation, and lose it over winter. Body weights therefore fluctuate widely within a species. A further complication is that bats have large babies, so a pregnant female may lose one third of her weight when her baby is born. The most reliable measurement to use is forearm length.

	General size	Forearm length	Wingspan
Mouse-eared bat	BIG	57–68mm	365–450mm
Bechstein's bat	medium	38–45mm	250–300mm
Natterer's bat	medium	36–43mm	250–300mm
Daubenton's bat	small	33–39mm	230–270mm
Brandt's bat	tiny	31–38mm	210–255mm
Whiskered bat	tiny	30–37mm	210–240mm

PRICKLY CUSTOMERS

Many familiar members of the Compositae in Britain are spiny, especially the burdocks and thistles. The spines of these plants play important parts in their lives and make them look rather similar, although they belong to various different genera.

Above: The carline thistle (*Carlina vulgaris*) is smaller than most of its relatives (with the exception of the stemless thistle), growing to a height of only 60cm (2ft) or less. It is also distinctive in that its florets are a yellowish straw colour tinged with mauve towards the centre of the heads, whereas most British thistles have purplish-red florets.

Opposite: The great burdock (*Arctium lappa*) has large, soft, heart-shaped leaves.

One feature shared by many thistles and burdocks is that they are biennials, completing their life cycles over two years. Some, however, are perennials or annuals.

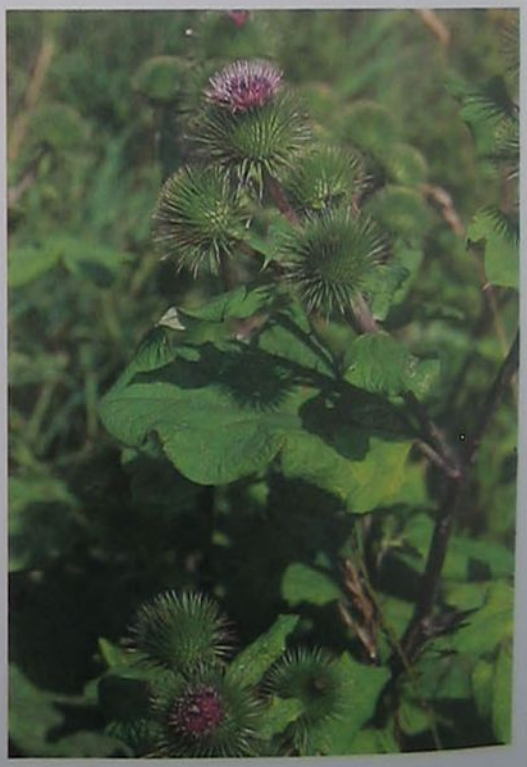
The burdocks Not as prickly as thistles, burdocks bear spines only on their bracts. The spines themselves are tipped with minute hooks that catch on clothing and fur and so help to disperse the fruits. Burdocks are unusual among Compositae in that their fruits are not dispersed singly by the wind but remain joined together in a head. Eventually, some time after the heads, or burs, have fallen or been carried away from the parent plant, they do disintegrate and all the fruits are released together in one spot. When they germinate a small colony of seedlings appears.

Unlike thistles, the great and lesser burdocks have large, soft, entire, heart-shaped leaves. Although our two commonest species can be distinguished by the size of their heads, as their names imply, they can also be recognised by snapping off one of their leaves. In the lesser burdock the petioles, or leaf stalks, are hollow inside, whereas those of the great burdock are solid.

Spines for protection The star thistle resembles the burdocks in that only its bracts are spiny but, while its leaves are soft, they are deeply lobed and thus more like those of the thistles.

The spines of this thistle, and others, are not involved in fruit dispersal (which is carried out by the wind), but protect the plants from grazing animals. They are efficient against most grazing mammals and insects, but not against goats or donkeys. The flower heads of all thistles are always spiny, while the stems and leaves of certain species are not. It is most important for the flower heads – the reproductive part of the plant – to be protected.

The carline thistle is an example of a thistle with spiny bracts and leaves but stems which, though not spiny, are densely covered with cottony hairs. The spiny bracts of this thistle are distinctive because the outer ones are straw coloured (not purple) and, in dry weather, spread out to resemble the ray florets of a chrysanthemum. In damp weather the heads close up again. This opening and closing of the heads serves to restrict the release of the fruits to the periods of relatively dry weather best suited for their dispersal. Carline thistles are found on poor soils – often on very dry sands on coastal dune systems, and also on chalk grassland.



Roots and rosettes The largest group of British thistles belongs to the genus *Cirsium*, all of which have spiny bracts and leaves, but only some of which possess spiny stems. One way of recognising members of this genus is to pull a few of the florets or fruits from a head and examine the pappus hairs. In *Cirsium* thistles the individual hairs are feathery even when seen with the naked eye. Most other thistles have simple hairs.

Some members of this genus are perennial plants, the melancholy thistle, for example, living for many years. Over the years a deep taproot grows, making these thistles very difficult to eradicate once they have become established as weeds. The taproots, which are quite long even in the biennial species, provide the thistles with further protection against grazing and also a means of surviving over winter. When a thistle plant is cut back to ground level, new leaves will usually sprout from the top of the taproot, drawing on the considerable reserves of food it contains. In winter, thistles die back until they are virtually reduced to their subterranean root systems.

In spring the first leaves to reappear form a rosette, closely pressed against the ground where their position, as well as their spines, protect them from being eaten while the plant gains sufficient energy through photosynthesis to ensure later rapid growth of the stems. The rosette leaves also smother any competing species nearby. When the upright stems appear, their leaves are usually quite different in shape from those of the rosette, generally being narrower and more deeply dissected.

Quick-spreading annual One British thistle, the milk thistle, is often an annual, growing, like other annuals, from seeds to flower and produce fruits in a single year. The high rate at which the milk thistle can therefore produce fruits enables it to spread and colonize new areas very rapidly. It is quite common on waste ground in some lowland parts of Britain where it has become naturalised after being introduced from southern Europe.

The prominent white veins on the leaves give the plant its common name and are one way of recognising it. The bracts are also distinctive, being more or less triangular with spiny margins and having stout yellow spines at their tips.

Spiny stemmed thistle In the most spiny thistles even the stems are thickly spiny, usually with the spines borne on wing-like welts or extensions of the stems. In the welted thistle these welts are continuous, extending the full length of the stem. The leaves of this thistle have spiny margins and the narrow bracts are tipped with weak spines.

Above: The woolly thistle (*Cirsium eriophorum*) takes its common name from the dense white cottony hairs that coat the underside of its leaves and heads. The British populations of this species are sufficiently distinct from those growing on the Continent to be recognised as a subspecies, *britannicum*. The differences, though slight, presumably reflect the effects of thousands of years of isolation from the continental populations. The woolly thistle grows on grasslands and roadsides with calcareous soils and occurs mainly in southern Britain, although even there it is uncommon.

Star thistle (*Centaurea calcitrapa*) grows on waste places on chalk. Rare. Flowers July-Sept. Ht to 60cm (2ft).

Melancholy thistle (*Cirsium helenioides*). On hilly grassland, scrub. Flowers June-Aug. Ht to 70cm (27½in).

Milk thistle (*Silybum marianum*). Naturalised on waste ground, often an annual. Flowers June-Aug. Ht to 2m (6½ft).

Welted thistle (*Carduus acanthoides*). Damp hedges, stream sides. Flowers June-Aug. Ht to 1m (3ft).

Lesser burdock (*Arctium minus*). Waste places, wood edges. Flowers July-Sept. Ht to 1.3m (4¼ft).

BLACK-AND-WHITE WAGTAILS

Pied wagtails are far commoner than the two other species of wagtails in Britain and Ireland. On almost any area of turf, shingle or rock, in towns or in the countryside, they can be seen hunting insects, with quick dashes, swerves and dramatic leaps into the air.

Above: A female pied wagtail at the entrance to her nest in a rock crevice. Unaided by the male, she builds the nest of mosses, grasses and dead leaves, and lines it with feathers or wool. Her clutch normally consists of five or six eggs, which are greyish-white and freckled with black or brown. She also undertakes most of the incubation, which lasts for two weeks; but she hands over responsibility for feeding the young to her mate when the time comes for her to lay again.

The pied wagtail is a familiar, lively and popular neighbour of man. Its bold black and white plumage, conspicuous habits and loud, distinctive 'chis-ick' call are easy to recognise and help to make it so well-known. It is surprisingly widespread, too: as widely distributed as any British bird, it breeds throughout our islands (but only occasionally on the Shetlands) and is thoroughly at home in city centres and on riversides, meadows, farms and seashore – in fact, almost anywhere except the open mountains and in woodland. One of its commonest vernacular names, water wagtail, is not as applicable as it might be, for it is not as closely associated with water as its relative, the grey wagtail. It is predominantly a bird of moist places, but not necessarily of the very margins of open water.

The pied wagtail is a truly British and Irish species, for its breeding range is virtually confined to these islands. It is replaced on the Continent, and as far north as Iceland, by the grey wagtail race referred to – somewhat confusingly – as the white wagtail. Birds belonging to this Continental race migrate through Britain in spring and autumn to and from their northern breeding areas, which are in northern Scandinavia and Iceland. Some occasionally stay to breed in Scotland and on the northern and western islands. These birds are noticeably whiter than our pied wagtails, and in spring it is easy to distinguish them from the British race. In autumn the task is much more difficult, as the young of both races are very similar.

Chasing after a mate As April arrives each year, the wagtails prepare for another breeding season. Males begin to establish territories, and several of them may pursue a single female in erratic and excited chases, each displaying to her when on the ground by throwing back his head and displaying his bold black gorget (throat patch). The competition of courtship eventually results in a successful pairing; then the newly paired birds spend some days together strengthening the bond between them, and establishing their breeding territory and nesting site.

Pied wagtails nest in a wide variety of sites,

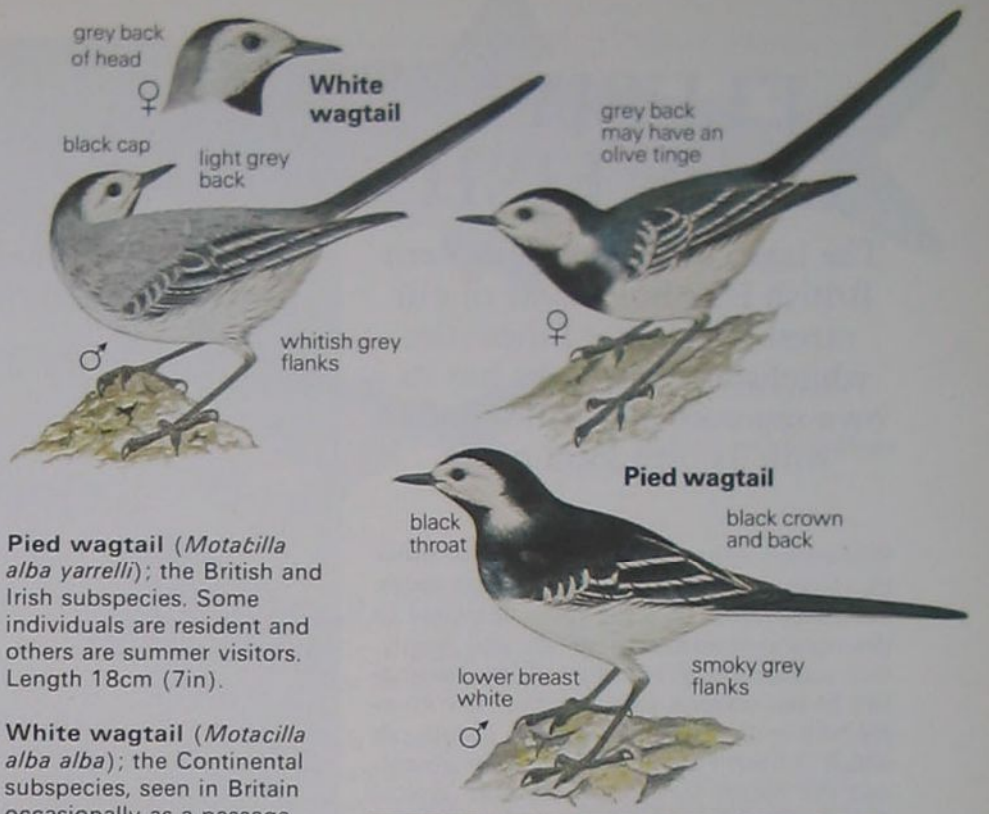
wherever an adequate crevice will conceal the nest. As well as choosing holes in banks, ivy-covered trees or cliffs, they often favour man-made objects: farm machinery, outbuildings or woodstacks are common sites.

A partial migrant All wagtails are insect-eating birds, but only the yellow wagtail migrates completely to warmer latitudes when the British winter reduces the abundance of its food. The pied wagtail demonstrates an interesting half-way stage between migration and year-round residence.

The appearance of increasing numbers of pied wagtails on school playing fields, in town parks and sewage farms in August and September is evidence of the fact that at least part of the population is migratory. In the south of Britain young birds predominate among those that migrate, but from further north there is a greater percentage of adults. All these birds flying south from Britain are bound for south-west France and Iberia, as is shown by the recovery of ringed birds. Birds from the south of England tend to travel further than those of more northerly origin; some of the southern birds fly as far as Morocco.

The other part of the population remains in Britain, one of the few species of insectivorous birds to gamble on finding an adequate supply of insects through the winter months as an alternative to facing the hazards of a long two-way migration. Through the British winter, the pied wagtail's secret lies in the ever-replenishing supply of insects to be found at the edge of water. Individual birds establish themselves in a winter territory along a river bank (sometimes a lake or other stretch of water) and defend it resolutely against others of their kind.

They feed along a fixed route near the water edge, returning each time to the starting point by the time the waters of the river or lake have delivered another supply of tiny insects and other invertebrates. To share the territory with another bird would be self-defeating for both, and would tip the balance between survival and failure. Defence of the territory is therefore crucially important.

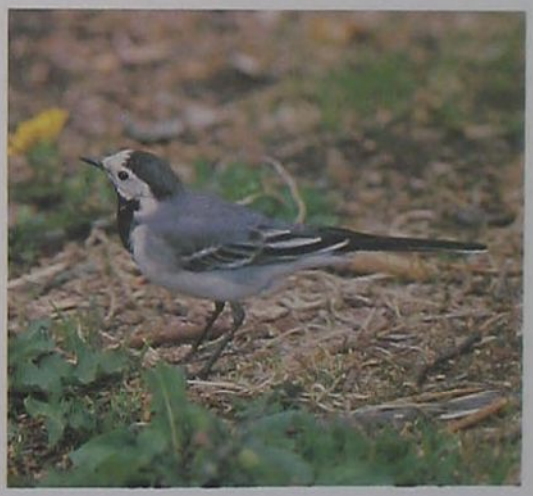


Pied wagtail (*Motacilla alba yarrelli*); the British and Irish subspecies. Some individuals are resident and others are summer visitors. Length 18cm (7in).

White wagtail (*Motacilla alba alba*); the Continental subspecies, seen in Britain occasionally as a passage migrant.

Right: The white wagtail is similar in appearance to the female of the pied wagtail, but its back is a lighter shade of grey.

Below: A female pied wagtail stands on a log in a typical jaunty attitude. Pied wagtails forage energetically, running jerkily on short turf, shingle or rock. With tails flicking non-stop, they make rapid dashes and swerves to catch their insect prey. Sometimes they leap into the air in dancing flight, to catch insects on the wing.



Communal roosts At most times of the year outside the breeding season (except when winter is at its severest), pied wagtails roost communally, normally choosing reedbeds, scrub or bushes. An interesting development of this has been an increasingly common adaptation to the urban environment – roosting on buildings and trees in city centres. Here the winter temperature can be a little higher than in the open countryside.

In a further adaptation to man's presence, they have been recorded as roosting in commercial glasshouses, sometimes in large numbers. Heated glasshouses obviously have enhanced survival value for them in cold winter months, and may also be thought of as giving security from predators. On the other hand, however, little owls and cats have sometimes discovered these roosts, and as there is small chance of escape the results can be disastrous.

ELUSIVE LAKE FISH

The lakes of the north-western British Isles hold some of our rarest freshwater fishes – the whitefishes. Each lake has its own separate population, often with its own local name.

Whitefishes are a group of freshwater fishes that form a small family in the salmon order, Salmoniformes. They are quite unrelated to the marine 'whitefishes' of the cod family, their name coming from their silvery, herring-like bodies (indeed, they are often known as freshwater herrings). The small mouth, in which the teeth are either minute or absent, and the deeply forked tail are both typical features of whitefishes, as are the large silvery scales. All whitefishes also have a fleshy adipose (fatty) fin lying between the dorsal and the tail fins, a characteristic of salmoniform fishes.

Local races Whitefishes are an extremely confusing group to classify because many local races have developed in different areas. In Britain, whitefishes are known under five different names – powan, schelly, gwyniad, vendace and pollan. All were originally described as endemic, occurring nowhere else in Europe. The powan, schelly and gwyniad were grouped as the same species, *Coregonus clupeoides*, the vendace as *C. vandesius* and the pollan was *C. pollan*.

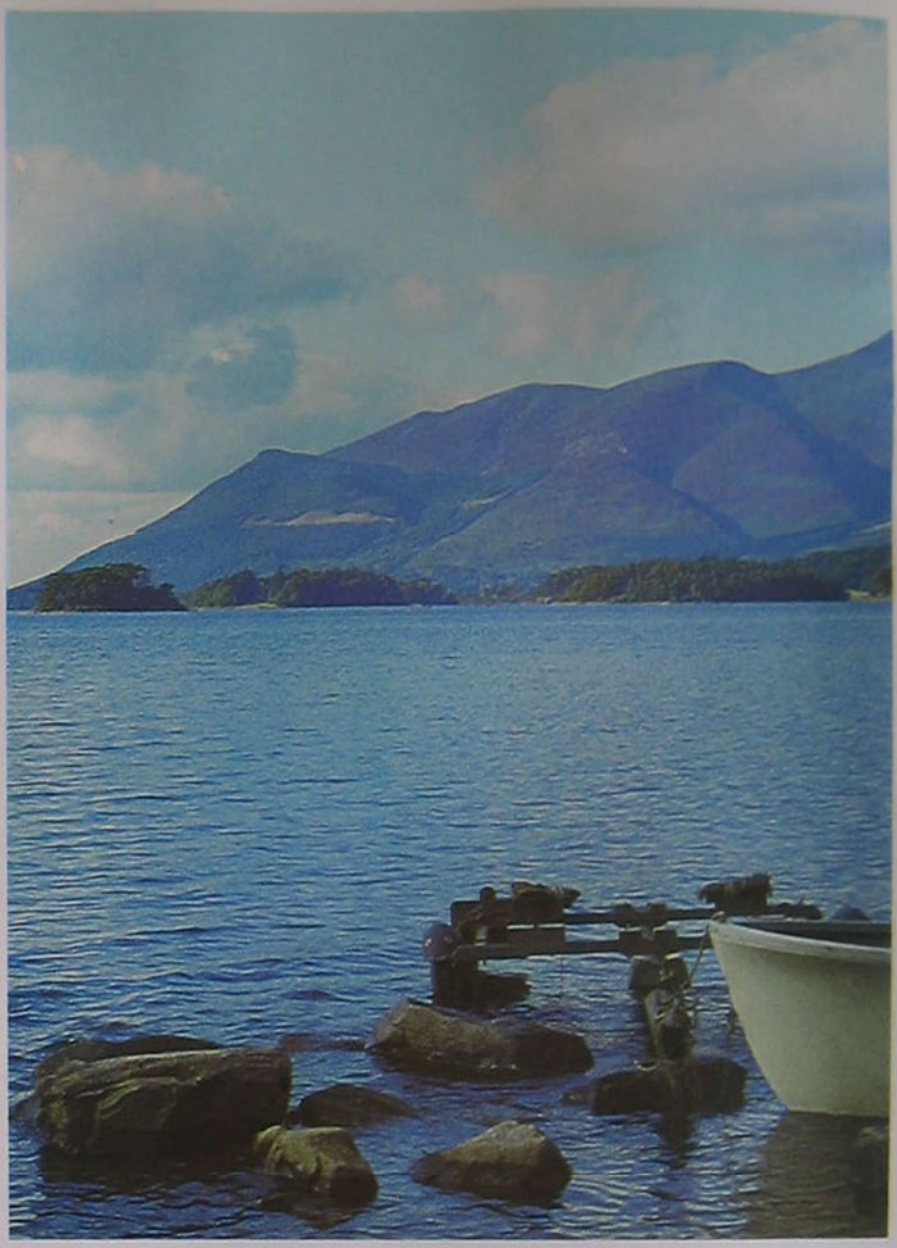
Gradually, it became apparent that most of the British populations are merely races of mainland Europe species. Thus the powan, schelly and gwyniad, and the vendace were reclassified as belonging to two species of whitefish quite common in northern Europe: *C. lavaretus* and *C. albula*, respectively. The pollan remained a problem for some years until studies of its bones, and more recently biochemical studies, suggested that it is the same as *C. autumnalis*, a species found only in Asia and western North America. How it reached the Irish waters in which it is now found is still a mystery.

Northern dwellers Whitefishes are cold-loving species found all around the more northerly parts of the Northern Hemisphere above about latitude 40°. In the British Isles, they are rare and few people have ever seen one alive. There are 14 known localities for them – three waters in Scotland, five in England, five in Ireland and one in Wales.

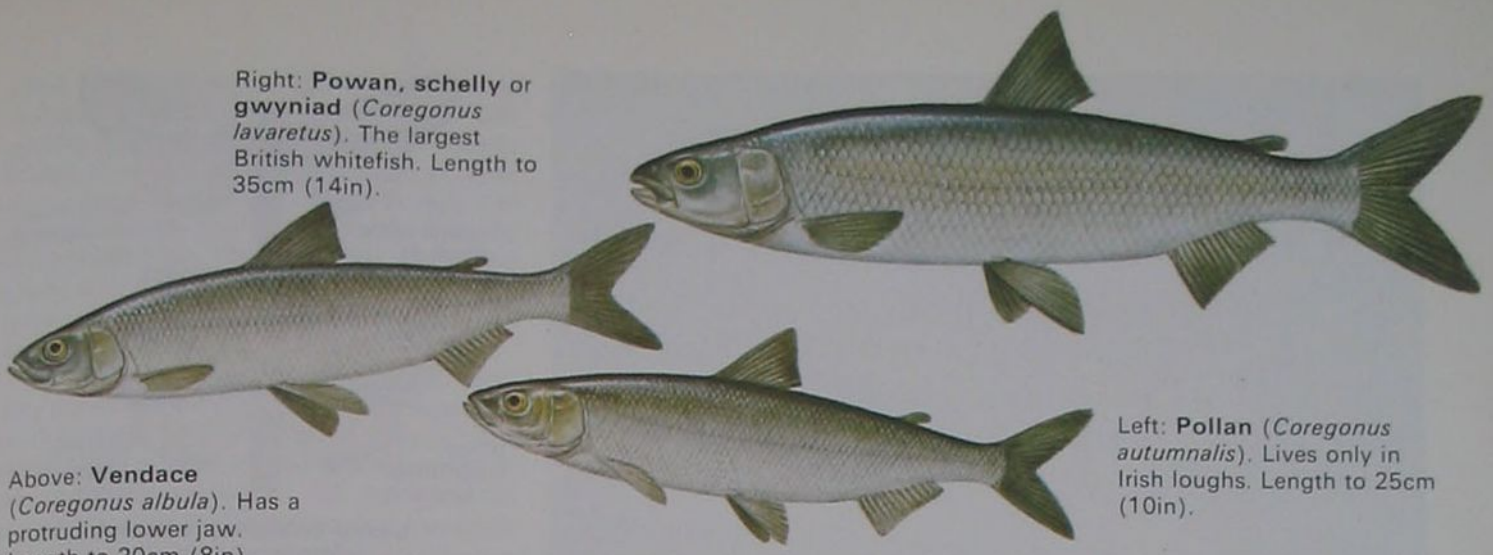
Whitefishes are usually found in large deep lakes where the water is well oxygenated and relatively cool, even in the summer. They tend to be found in the upper layers of the water, occupying the same niche in lakes as herrings do in the sea. No doubt, this is why these two unrelated fishes have evolved to look superficially similar. Adult whitefishes usually stay in deeper water away from the shore during the day, at dusk moving into shallower water near the shore to feed. At dawn, they retreat back to the safety of darker, deeper water.

Zooplankton form an important part of the diet of both young and adult whitefishes, though adults also take bottom-dwelling invertebrates, often in large numbers during winter. Generally, vendace rely more on plankton than do the other species. Surprisingly, one of the main food items during the spawning period is their own eggs.

Whitefishes are not confined solely to their respective waters. Specimens are found occasionally in the rivers flowing out of the waters and, more rarely, in the in-flowing rivers. Thus, schelly have been recorded in the River Eden considerable distances below Ullswater, and gwyniad have been found in the River Dee below Llyn Tegid.



Above: Under one name or another, whitefishes can be found in 14 different waters in Britain and Ireland. Shown here is Derwentwater in the Lake District, which has a population of vendace. Whitefishes are rarely caught by anglers. However, they do respond to specific lures, when fished in the right place and at the right time, and in recent years some anglers have been successful in catching them. The present angling record among whitefishes is for a schelly of 737gm (1lb 10oz), caught in Ullswater in 1976, but without doubt there are larger specimens than this in British waters.



Right: **Powan, schelly** or **gwyniad** (*Coregonus lavaretus*). The largest British whitefish. Length to 35cm (14in).

Above: **Vendace** (*Coregonus albula*). Has a protruding lower jaw. Length to 20cm (8in).

Left: **Pollan** (*Coregonus autumnalis*). Lives only in Irish loughs. Length to 25cm (10in).

Winter spawning In the British Isles, whitefishes spawn during the winter. Clear yellow eggs are laid at night among small stones and gravel in shallow water, usually along shores washed with waves or on reefs, where the current is strong enough to provide adequate aeration for the eggs.

At spawning, the males seem to come in from deeper water to form large shoals, into which the ripe females swim to spawn. The eggs are laid and fertilised in mid-water and then sink to the bottom where, being slightly adhesive, they stick to stones and weeds.

The incubation period is 80 days at 5°C (41°F); the eggs hatch in early spring, when the surface waters of the lakes are warming and the zooplankton population is increasing. The young fishes can swim very fast, even immediately after hatching. For the first few days they live on their small yolk-sacs. After that, they begin to feed on plankton.

The young whitefishes are about 1cm ($\frac{3}{8}$in) long at hatching but, by the end of their first year, they have grown to about 8cm (3in), and double that a year later. Growth rates vary between different species, of course, and between different populations. Thus powan in Loch Lomond are about 25cm (10in) long when mature after three years, whereas those in Loch Eck are only just over 20cm (8in) long at maturity.

Commercial value Although whitefishes are an important food source world-wide, in the British Isles they are eaten only rarely. There is a long-established fishery on Lough Neagh, where pollan are netted and marketed in Belfast and Liverpool, but nowhere else in the British Isles are whitefishes caught commercially.

Despite their lack of commercial importance, whitefishes are worth conserving since they are interesting and rather mysterious. Already, one stock (in Castle Loch) has disappeared, and another (in nearby Mill Loch) may recently have done so. All the other waters in which they live are subjected to increasing pressure from recreation, water supply, pollution and so on, and measures should be taken now to protect their whitefish populations, each of which is unique in some way. These elusive fishes deserve a permanent place in our fauna.

Above: All whitefish species are slender silvery fishes with a deeply forked tail and a characteristic fleshy adipose fin lying behind the dorsal fin. Distinguishing the three species is not easy and, apart from the vendace's protruding lower jaw, size is the best guide.

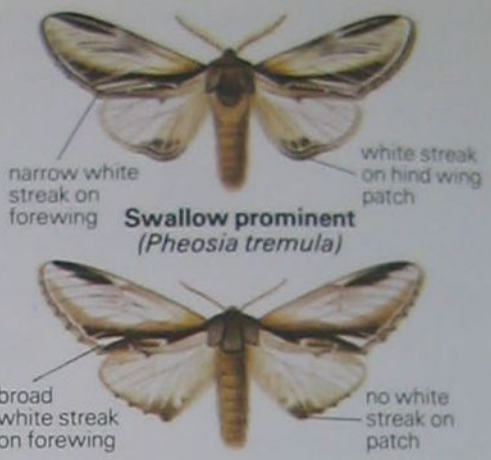
Below: The location of whitefish populations in the British Isles. These waters have a curious distribution, for they surround the Irish Sea, which acts as a central point. Why this should be is a matter of great interest and speculation among scientists.
Stocks of whitefishes have recently been introduced to lochs in the areas marked (a) and (b) from Loch Lomond and Mill Loch.

Whitefish waters in the British Isles

Locality	Maximum depth (metres)	Surface area (hectares)	Scientific name	Local name
1 Loch Eck	42	458	*Coregonus lavaretus*	powan
2 Loch Lomond	198	7040	*Coregonus lavaretus*	powan
3 Red Tarn	25	10	*Coregonus lavaretus*	schelly
4 Ullswater	63	894	*Coregonus lavaretus*	schelly
5 Haweswater	32	140	*Coregonus lavaretus*	schelly
6 Llyn Tegid	42	160	*Coregonus lavaretus*	gwyniad
7 Mill Loch	17	13	*Coregonus albula*	vendace
8 Derwentwater	22	530	*Coregonus albula*	vendace
9 Bassenthwaite	31	535	*Coregonus albula*	vendace
10 Lough Ree	32	15540	*Coregonus autumnalis*	pollan
11 Lough Derg	36	12691	*Coregonus autumnalis*	pollan
12 Upper Lough Erne	27	3385	*Coregonus autumnalis*	pollan
13 Lower Lough Erne	69	11137	*Coregonus autumnalis*	pollan
14 Lough Neagh	31	39627	*Coregonus autumnalis*	pollan

CUNNINGLY CONCEALED MOTHS

Ten species of prominent moths are established in Britain, all of them with caterpillars that feed on deciduous trees and bushes. The adults are experts at camouflage, some of them looking like dead leaves and others imitating chips of dead wood.



Swallow prominent
(Pheosia tremula)

Lesser swallow prominent
(Pheosia gnoma)

Below: Adult iron prominent moth (*Notodonta dromedarius*). This species flies in early summer. There is sometimes a second generation, with new adults appearing in September. Note the good camouflage of the moth against the tree.

The family Notodontidae is represented in Britain by over 20 resident species of moths, including the well-known puss and lobster moths and the buff-tip. About half our notodonts, however, belong to a group called the 'prominents'. The name refers to a tuft of scales on the middle of the hind border of each forewing. When the moth is at rest these lie together and form a prominence in the insect's dorsal profile; this helps to break up its outline and no doubt assists the remarkable camouflage which some of these moths display. Most of them are medium sized moths with wings spanning 3-5cm (1-2in), although the great prominent's wingspan may exceed 7cm (2¾in). All the prominents are fast, night-flying moths, resting by day on trees and bushes.

There are 13 species of prominents listed as British, but two of them are very rare vagrants that occasionally fly in from the European mainland but have never formed resident British populations, and one, the white prominent, is presumed to be extinct here. The remaining 10 species are all established in southern England and over half range widely throughout the British Isles.

The iron and the pebble In the iron prominent moth the forewings are dark brown with obscure reddish and yellowish markings that give them a rusty appearance. Birch woods are its usual habitat and the normal food of the caterpillar is birch, but it is sometimes found on alder and hazel as well. The caterpillar is an extraordinary-looking creature, varying from green to brown in colour, with a series of conspicuous dorsal humps–three large and one small one on the back and another near the tail. The hind end is raised at an angle to the body, giving the caterpillar a contorted appearance.

The pebble prominent has light brown forewings with a darker, irregularly oval mark (the 'pebble') occupying the tip of the wing. At rest the moth looks like a broken twig and is inconspicuous against most natural backgrounds. It can be found on sallows, willows and poplars, on the leaves of which the caterpillar feeds. The caterpillar's shape and posture are similar to those of the iron prominent, but there are only two humps on the back. It is grey on the front half of the body, but the hind part, which is raised up, has orange-brown markings.

The great and the coxcomb The great prominent moth is the largest species and has greyish brown forewings streaked and mottled with a darker brown colour, and nearly

white hind wings. It is fairly common in southern England and is confined to oak woods; the moths rest by day on the trunks of oak trees and are well concealed by their resemblance to the bark. There is only one generation in the year and the moths fly early, in April and May. The caterpillar is large and green with oblique reddish and yellowish stripes along the sides. It feeds only on oak leaves.

The forewings of the coxcomb prominent vary from dark to light brown with a pattern of ill-defined bands and dark streaks. The prominence is large and the outer margins of the wings are scalloped. All this gives an irregular outline and the effect of a crumpled, withered leaf. The camouflage is effective both on a background of dead leaves and among the foliage of birch. The caterpillar of this species is the least choosy of the prominents as regards food plants: it has been found on a wide variety of trees and bushes, including birch, oak, beech, hawthorn, poplar and sallow. It is green with a dark line on the back and a yellow line on each side; near the tail end are a pair of bright red humps.

A pair of lookalikes The swallow prominent and the lesser swallow prominent overlap considerably in size and are similar in appearance. They are pretty insects with beautifully patterned white and dark brown wings.

Two features distinguish these moths as adults. At the obtuse inner angle of the forewing of both there is a tapered white streak, narrow in the swallow, broader and wedge-shaped in the lesser. Secondly, at the corresponding angle on the hind wing in both species there is a small dark brown patch; in the swallow this is divided by a white streak parallel to the wing margin, while in the lesser the brown patch is entire. These are both minor features, and in general appearance the two are almost identical.

In their early stages, however, these two moths are wholly distinct. In the first place they have different food plants: the swallow caterpillar feeds on poplar and aspen, the lesser on birch. Both caterpillars are smooth and elongated with a rounded dorsal hump at the hind end, but that of the swallow is green,

Above: The coxcomb prominent moth (*Ptilodon capucina*) is common all over Great Britain and Ireland and two generations of adults fly each year, one in May and June, the other in July and August. The second generation overwinters as pupae.

Left: The quite amazing camouflage of the pebble prominent moth (*Eligmodonta ziczac*) can be seen in this picture, where the moth looks as if it is nothing more than an irregular bump on the twig. This species is one of the commonest of our prominents. There are two generations in summer, the adults flying in May and June and again in August. It overwinters as a pupa.

Below: **Scarce prominent moth** (*Odontosia carmelita*) and caterpillar. This species feeds on birch.

Above: **Plumed prominent moth** (*Ptilophora plumigera*) and caterpillar. The food plant is maple.

Above: **Maple prominent moth** (*Ptilodontella cucullina*) and caterpillar. Field maple is the only food plant.

Above: This strange-looking creature is a pebble prominent caterpillar. The raised, rather contorted, appearance perhaps simulates a crumpled, partly withered leaf, and is designed to camouflage the caterpillar.

Below: The largest of our prominent moths is the great prominent (*Peridea anceps*). Again, the camouflage of this species is extraordinary. The adults rest by day and are well-concealed on the oak trees on which they live.

while that of the lesser is brown with a yellow stripe along each side. Both species are well distributed over the whole of the British Isles.

The rarer species Rather like the coxcomb in appearance, the maple prominent has forewings divided up into areas of dark and light brown; there is also a distinctive mottled white patch along the outer end of each forewing. At rest the moth looks very like a piece of dead wood. The caterpillar feeds only on field maple and is pale green with a darker stripe along the back, and a hump near the rear end of the body, which is raised up like that of the iron and the pebble. This is not a common moth and is almost confined to south-eastern England.

Extinct in Britain

Two of the 13 prominent moths listed as British are rare migrants, while another one, the white prominent (*Leucodonta bicoloria*), shown below, was recorded occasionally in England in the 1880s and more regularly in County Kerry in Ireland up to 1938. Since then none has been seen at all and the moth is presumed to be extinct in the British Isles. It lives in birch woods and is white with a roughly L-shaped orange mark and a few black dots on each forewing. Let us hope that it is still lurking somewhere in the British Isles, waiting for some fortunate naturalist to rediscover it.

The forewings of the scarce prominent are purplish grey, and darker along the front of the wing, where there is a distinct yellow mark near the tip. The caterpillar feeds on birch and is green, freckled with yellow, and with a yellow stripe on each side. The adult moth flies early, mainly in April, and is found sparsely in birch woods.

The plumed prominent, a small, light reddish brown species, is our scarcest prominent and is confined to certain localities on the chalk downs of south-eastern England. The antennae of the male are very broadly feathered and the moth flies in November and December, when males come freely to lights exposed in their restricted haunts. The caterpillar is green and feeds only on maple.

Clever camouflage In the pale prominent moth (*Pterostoma palpina*) the streaky pale brown wings have a texture and colour very closely simulating dry decayed wood. When it is at rest the moth's body projects beyond the wings at the back and a pair of feather-like 'palps' stick out in front. These features, together with the prominence, make up an outline so irregular that the insect looks just like a piece of dead wood. The caterpillar, which feeds on poplar, is bluish green with darker and paler longitudinal lines and no humps or contortions. In the south of England the moth is common and has two generations; it is, however, less common in Ireland and in the north.

SALTMARSH AND SAND DUNE WALKS

Holkham, the largest coastal nature reserve in England, is sited along the North Norfolk coast and is exceptionally rich in seaside flora and fauna.

A convenient point for our first walk – through the western section of Holkham reserve – is from the end of Lady Anne's Road, which lies a little less than 2km (1 mile) west of Wells-next-the-sea. From the end of this road westwards to Gun Hill and back is a distance of about 8km (5 miles). If you want a longer walk, start from the end of the Wells beach road, so adding another 5km (3 miles) to the return trip.

Reclaimed land Some 350 to 400 years ago the land lying north of the present A149 coast road between Overy Staithe and Wells was one great saltmarsh, the seaward face of which was protected by a line of sand dunes. Various reclamation schemes were carried out and by the mid 19th century virtually all the saltmarshes had been reclaimed and are now, like the fields on either side of the Lady Anne's Road, given over to cattle grazing or arable crops.

The sand dunes between Wells and Overy Staithe were planted with Corsican pines about a century ago in order to stabilise the dunes and prevent their encroaching on to the reclaimed marshland. The western extremity of this pine woodland lies some 2km (1 mile) west of Lady Anne's Road.

These reclaimed marshes are criss-crossed by some 80km (50 miles) of drainage dykes that support a wide variety of aquatic plants, such as water-crowfoot, brooklime, frogbit,

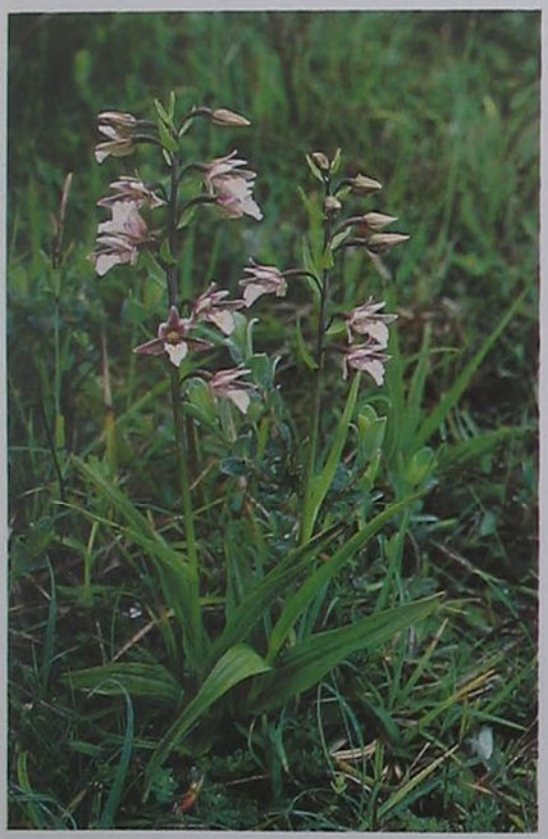
Above: Established in 1967, Holkham Nature Reserve covers just under 4000 hectares (1000 acres) of the North Norfolk coast between Overy Staithe in the west and Blakeney in the east. The reserve divides neatly into two sections, clearly separated by the small town of Wells-next-the-sea and its approach channel. One of our walks covers sand dune land (shown here), the other a saltmarsh.

Below: Look out for black-headed gulls on the saltmarsh.

water speedwell, amphibious bistort, hemp agrimony and pondweeds. They also provide a breeding habitat for various aquatic animals such as the common frog and common toad – in May certain sections of the dykes may contain hundreds of the latter. Invertebrates most likely to be seen by the casual visitor include such dragonflies as the common ischnura and broad-bodied libellula. Among the many birds frequenting the reclaimed land are skylarks, lapwings and yellow wagtails, reed and sedge warblers, reed buntings and, among the wildfowl, Canada, greylag, pink-footed and white-fronted geese. And up to 1000 golden plovers may sometimes be seen in one scattered flock.

The pinewoods From the end of Lady Anne's Road the path runs parallel with the landward edge of the pines, which enables you to maintain extensive views over the reclaimed marshland to the south. The dense shade of the pinewoods restricts wildlife somewhat, and the animals you may see there vary according to the season and time of year.

Above: A brilliantly coloured garden tiger moth – just one of the many insects to be seen at Holkham.



Left: While a variety of common wild flowers, such as red campion, ragged robin and foxglove, can be seen along the margin of the pinewoods in Holkham, and include a large colony of marsh helleborines (shown here), the most interesting flowers are those of the sand dunes. However, the limited flora found beneath the pines includes one or two colonies of creeping lady's tresses (a naturalised alien) and the rare yellow bird's nest. In autumn there are several different species of fungi characteristic of pinewoods to be seen.

Red squirrels are present, but unfortunately only in small numbers, and they are not easy to spot. Among the breeding birds are a few pairs of crossbills, but these, too, can be difficult to locate unless you are familiar with their characteristic call note. However, other breeding species, such as kestrels, tawny owls, green woodpeckers, goldcrests and coal and willow tits present no such problems. In fact, the most exciting birds to be seen here are the migrants and winter visitors, but particularly the former. Given easterly winds almost any birds may appear in these pines and marginal scrublands. The autumn of 1981, for example, produced large falls of goldcrests, along with much less common species such as the wryneck and the yellow-browed, barred and Pallas' warblers. From late autumn through the winter woodcock may be flushed out frequently, and the occasional great grey shrike can also be seen.

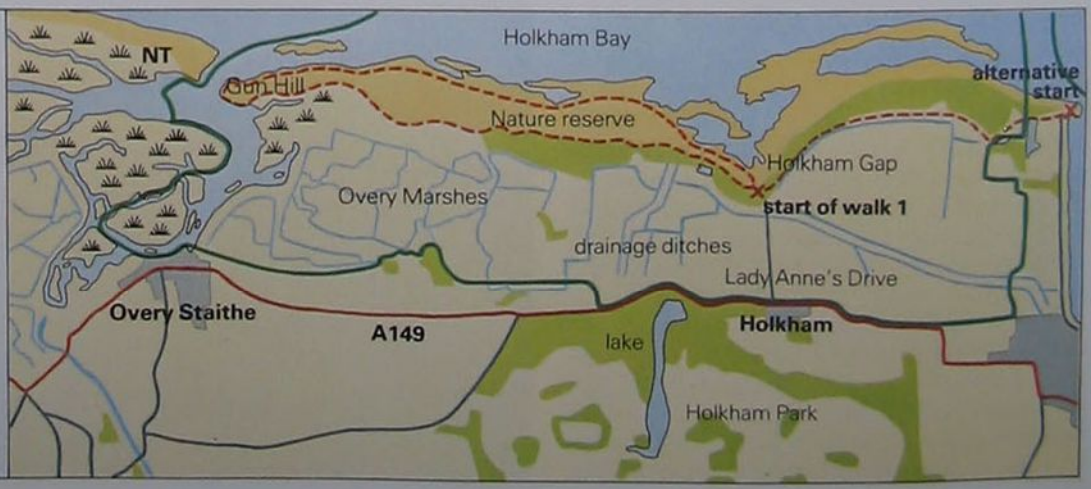
To Gun Hill Emerging from the shelter of the pines, the path continues westwards along the inland edge of the dune system to Gun Hill, a large dune with an eroded summit overlooking Overy and Norton Creeks. The flora of the dunes is very much dominated by

Walk 1 – sand dunes

Start at the end of Lady Anne's Road, a little less than 2km (1 mile) west of Wells-next-the-sea. From the other end of the road follow the path parallel with the landward edge of the pines, then continue westwards along the inland edge of the dune system to Gun Hill, which overlooks Overy and Norton Creeks. Return the same way, or follow the shoreline back to Holkham Gap, and Lady Anne's road.

marsh

sand dunes



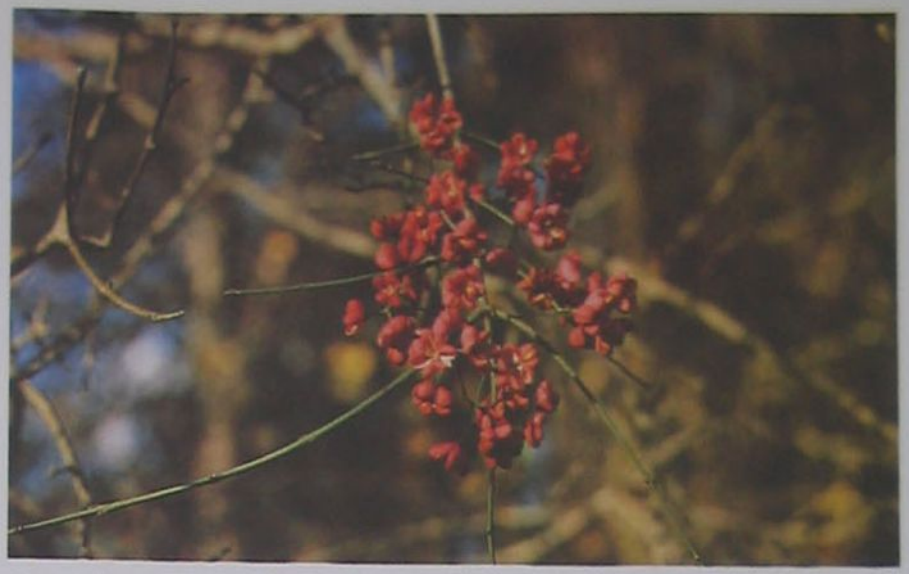
marram grass and sand sedge, and grazed by abundant rabbits.

Many typical sand dune plants can be found here, including bee and pyramidal orchids, yellow-wort, carline thistle, plough-man's spikenard (present in these dunes because of the high content of calcareous shell tissues), and, much rarer, Jersey cudweed. A short distance beyond the pines and to the left of the path, are several small pools where water fennel blooms in profusion in May, and which support a small colony of natterjack toads.

From Gun Hill the return trip can be made back along the same route, or alternatively along the shore to Holkham Gap, which gives you an opportunity to see waders and other shore birds which, in winter, may include flocks of snow buntings and possibly shore larks.

The saltmarsh walk Our second walk covers the eastern section of the reserve, which consists of one of the most extensive saltmarshes in England. Prior to World War II large flocks of sheep were grazed on the marsh, but the practice was not resumed after the War.

A convenient starting point is a footpath leading down to the marshes from the A149 coast road, approximately 1km (just over half a mile) east of the junction of the A149 and the B1105 just east of Wells. The path passes between arable fields paralleled first with hedges and then by drainage ditches. On reaching a stile, follow the path left along a drainage ditch for a short distance, then turn right past a small area of reeds (where a pair or two of reed warblers breed), and walk diagonally left to gain the sea wall that extends east from Wells to this point. Cross over the end of the sea wall and follow the footpath through a small thicket and out into the open. You can now walk eastwards along the landward edge of the saltmarsh, with a hawthorn hedge and scattered elders to the right.

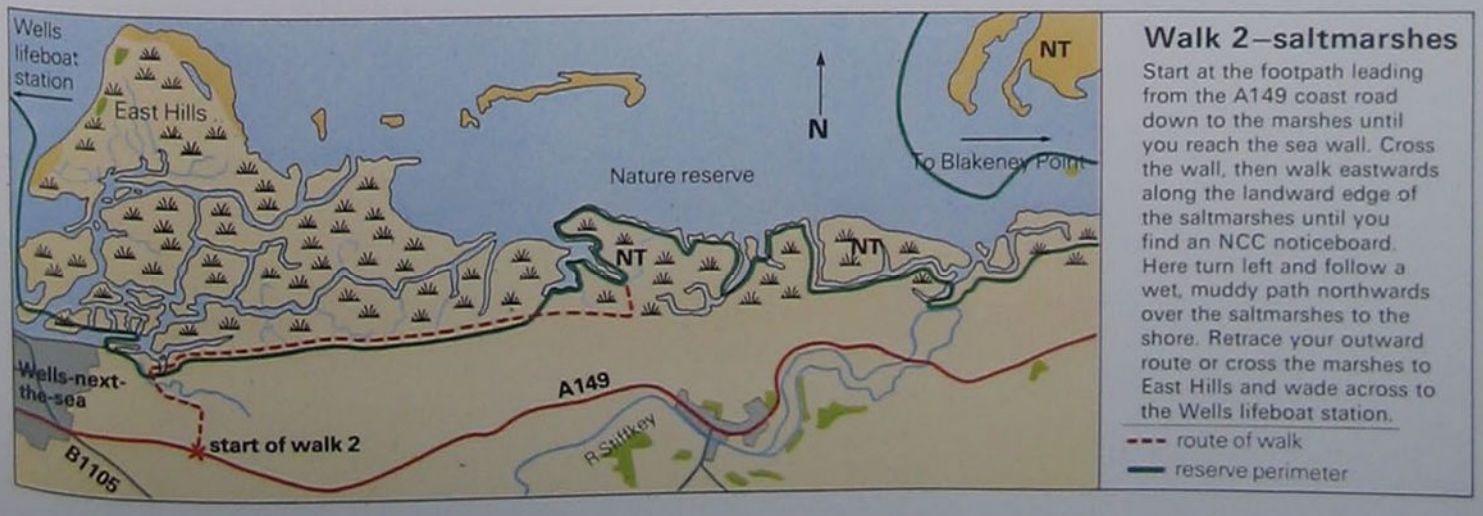


Above: One of the more spectacular shrubs found at Holkham, spindle produces a crop of bright fruits in the autumn.

Below: Sea spurrey, with its attractive pale pink flowers, can be found on the saltmarshes of Holkham in mid-summer. Like such species as scurvy grass, it prefers to colonize the higher parts of the marshes.

At the point where the footpath emerges from the thicket, look northwards over the marshes towards the sea. To the north-west the Wells lifeboat station is visible, while straight ahead across the saltmarsh are the sand dunes and pine trees of East Hills. These are virtually the only sand dunes within the reserve boundary east of the Wells channel, and the pines on them, like those to the west of Wells, were planted just over a century ago. In summer there is a very large breeding colony of black-headed gulls on the saltmarsh to the south of the East Hills. From the footpath it may seem that the colony is easily accessible, but in fact it is well sited within a complex of muddy creeks.

Gaining the shore Follow the footpath eastwards along the upper edge of the marsh for about 1.5km (1 mile) to a point where another



Walk 2–saltmarshes

Start at the footpath leading from the A149 coast road down to the marshes until you reach the sea wall. Cross the wall, then walk eastwards along the landward edge of the saltmarshes until you find an NCC noticeboard. Here turn left and follow a wet, muddy path northwards over the saltmarshes to the shore. Retrace your outward route or cross the marshes to East Hills and wade across to the Wells lifeboat station.

--- route of walk

— reserve perimeter

track comes in from the right; there is a Nature Conservancy Council reserve noticeboard on the left.

The hawthorn hedgerow on the south side of this path along the landward edge of the marsh provides a breeding habitat for various birds, such as bullfinches, greenfinches, chaffinches, yellowhammers and whitethroats. To the north of the path is the very distinct driftline of detritus deposited by the highest tides, a line also marked by low bushes of shrubby seablite in which reed buntings nest. This shrub is also found on raised areas lower down the marsh.

On reaching the reserve noticeboard, turn left and follow the well-drained but often wet and muddy path northwards over the saltmarsh to the shore; footbridges span the one or two large creeks along the route. It is advisable to check the tide times since the tide here comes in very quickly to flood the intricate system of creeks and channels that meander across the marsh. To be caught on the seaward side of the marsh at high tide may mean a long and often uncomfortable wait.

Vegetation The vegetation of this saltmarsh is restricted to barely 20 species of flowering plants, and some of these are not abundant. The route from the NCC noticeboard north to the shore is in fact a transect down the saltmarsh, and you will find that, generally speaking, there are distinct zones ranging from the stabilised upper marsh to the bare mud and sand of the shore, although there is also a considerable mosaic pattern to the vegetation.

Scattered across the marsh are numerous salt pans, formed by the failure of the vegetation to colonize wetter depressions in the flats. The vegetation around these salt pans is mostly a mosaic, consisting primarily of sea pink, sea plantain and sea wormwood, the latter having a powerful aromatic smell.

Above: The reclaimed marshland has considerable natural history interest. Breeding birds include the lapwing, skylark and yellow wagtail, with a few pairs of common snipe and redshank in the damper areas. Dense stands of common reed occur in swampy pockets and support breeding reed warblers, together with sedge warblers and reed buntings (shown here) in adjacent areas of mixed marsh vegetation. Late autumn and early winter see the arrival of additional lapwings, along with golden plover. Canada and greylag geese from nearby Holkham Park can be seen at any time.

Below: One creature to look for on the sands is the lesser sand-eel.

Scurvy grass, the first saltmarsh plant to flower, is found on the higher parts of the marsh and so, too, is sea spurrey whose pale pink flowers appear in mid-summer. At a slightly lower level come sea arrowgrass and a wealth of sea lavender, which gives a carpet of colour in July and August.

Further down the marsh, the rayless form of the sea aster becomes abundant. Saltmarsh grass or puccinellia is found from the mid to the lower levels of the saltmarsh, while sea purslane grows most commonly along the edges of the numerous creeks. At the seaward edge of the marsh are the mudflats where glasswort, annual seablite and cord grass occur, their roots helping to stabilise the mud. Finally there is the zone of bare mud with little more than algae and the aquatic flowering plant known as eel grass.

Bird life During the breeding season the commonest birds on the saltmarsh, in addition to those already mentioned, include redshanks, oystercatchers, shelduck and skylarks. During late summer and autumn large mixed flocks of finches (particularly goldfinches and greenfinches), starlings and woodpigeons feed on the marsh. Winter brings the excitement of flocks of brent geese (sometimes a thousand or more), wigeon and twite, and the occasional glimpse of a hen harrier and even a short-eared owl.

Beyond the seaward edge of the saltmarsh raised banks of sand and shells are found here and there along the shore, providing a breeding habitat for common and little terns, plovers and oystercatchers. When autumn brings the waders, then these banks make good observation points from which to view the flocks of dunlins, knots, curlews, bar-tailed godwits, grey plovers and other species that appear on the shoreline.

And back again This walk can be completed either by retracing the outward route or, if it is low tide, by crossing the shallow channel to gain the East Hills. From here you can wade the Wells channel at a point opposite the lifeboat station where the water will be about knee-deep. Don't attempt this, however, if the tide is starting to come in again.